

SOUTHWEST FISHERIES CENTER ADMINISTRATIVE

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**CROSS TABULATIONS OF CATCHES OF LARGE PELAGIC
SPECIES BASED ON HAWAII COMMERCIAL CATCH REPORTS,
JANUARY 1976-APRIL 1981. I. AREA FISHED AND
FISHING GEAR BY SPECIES**

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INTRODUCTION

Before the enactment of the Magnuson Fishery Conservation and Management Act of 1976, the National Marine Fisheries Service determined that there was a need to manage the fishery for billfish, mahimahi, wahoo, and shark in the western Pacific region and prepared a Preliminary Fishery Management Plan for doing so in 1978. The Western Pacific Regional Fishery Management Council is now proceeding with the development of a Fishery Management Plan for these same species. In the process of doing so, a need has been identified to document the domestic catch of these management unit species by various fishing gears and fishing zones around the Hawaiian Islands.

In support of this identified need, we have prepared this data summary using statistics provided by the Hawaii Department of Land and Natural Resources, Division of Aquatic Resources. Data from January 1976 through April 1981 are included in this report. Compared with previous years, there appears to be underreporting of tuna longline catches, especially in 1981. However, for the purpose stated above, these statistics are the best available, and we acknowledge the Division of Aquatic Resources for making them available to us.

Summaries of reported landings, sales, and revenue derived from the sales are presented in the following sections: Species Totals, Region Fished (All Species), Region Fished by Species, Region Fished by Gear Type (All Species), Region Fished by Gear Type and by Species, Gear Type (All Species), Gear Type by Species, Gear Type by Region (All Species), Gear Type by Region and by Species.

Some explanation of the tables is in order. Since the summaries are based on the statistics provided by the Division of Aquatic Resources, we have followed the naming conventions used by them. With respect to fish names: "swordfish" refers to billfish (Families Xiphiidae and Istiophoridae) of undifferentiated species, whereas "broadbill" is the swordfish (Xiphias gladius); "ono" is the Hawaiian name for wahoo (Acanthocybium solandri); sharks are divided into "hammerhead shark" (Sphyrna sp.) and "shark" (mostly Carcharhinidae) categories, both of which are mixtures of species. With respect to areas or regions, the State of Hawaii's fishery statistical zones are arranged in 0 to 2, 2 to 20, and beyond 20 nmi strata. Thus, it is not possible to summarize the data by 0 to 3 and 3 to 200 nmi zones without using some arbitrary approximating procedures. Also, catches from the Northwestern Hawaiian Islands can be differentiated from those in the main Hawaiian Islands, and we have chosen to do so in the following tables without regard to distance zones around the islands. With respect to fishing gear types, "flagline" refers to tuna longline fishing gear; "deep-sea handline" is generally a multi-hook gear fished in deep water for snappers whereas "inshore handline" gear is generally fished in shallower water for goatfish (the Mullidae), akule (bigeye scad, Selar crumenophthalmus), and other shallow water fishes; however, the distinction is not clear.

SPECIES TOTALS

When considering only the weight caught or sold, blue marlin (Makaira nigricans) is the most important species among the management unit species (Table 1). It may come as a surprise to some that wahoo and mahimahi, (Coryphaena sp.), are the next most important species. Sailfish (Istiophorus platypterus) is the least important and sharks are next to last. However, from the viewpoint of revenue, mahimahi and wahoo alternate as the most important species. Blue marlin, by this measure, drops to third most important, and sharks become the least important.

REGION FISHED (ALL SPECIES)

For the Hawaiian domestic fishery, the zone from 2 to 20 nmi is the most important for these management unit species in terms of weight and revenue (Table 2). The region beyond 20 nmi is generally the next most important, and the Northwestern Hawaiian Islands ranks last.

REGION FISHED BY SPECIES

Within the 0 to 2 nmi zone, wahoo is the most important species with respect to weight and revenue (Table 3). Mahimahi is the second most important with respect to revenue. Blue marlin, however, was more important in terms of weight in 1978 and 1979.

For the 2 to 20 nmi zone, blue marlin is by far the most important species in terms of weight, except in 1976 when striped marlin landings were greater. However, blue marlin ranks behind mahimahi and wahoo with respect to revenue in most years.

In the Northwestern Hawaiian Islands, wahoo is clearly the most important species with respect to weight and revenue.

In the offshore areas, beyond 20 nmi, mahimahi is generally the most important species in terms of weight and revenue.

REGION FISHED BY GEAR TYPE (ALL SPECIES)

In the 0 to 2 nmi region, the two top ranked gear types based on weight and revenue are trolling and deep-sea handline (Table 4). It is of interest that no flagline catches were reported for this zone in 1980.

For the 2 to 20 nmi zone, trolling gear is clearly the most important gear type. Flagline or tuna longline gear was the second most important in 1976 through 1979 but was replaced by deep-sea handline in 1980 and 1981.

In the Northwestern Hawaiian Islands, trolling has become the most important gear type, largely displacing deep-sea handline. Likewise in the region beyond 20 nmi, trolling has again become the most important gear type, but in this case flagline has been relegated to second rank.

REGION FISHED BY GEAR TYPE BY SPECIES

The largest catches in all regions were generally made on trolling gear (Table 5). The major species caught by trolling were ono, mahimahi, and blue marlin. Mahimahi and ono typically made up the greater portion of catch in pounds and dollars for the other gear types as well, except for flagline gear which produced larger catches of striped marlin (Tetrapturus audax).

GEAR TYPE (ALL SPECIES)

For all management unit species combined, trolling gear is the most important fishing gear type. In 1976 through 1979, flagline gear was the second most important, but deep-sea handline became so in the remaining years (Table 6). Inshore handline gear is the least important.

GEAR TYPE BY SPECIES

As indicated in Table 5, the largest catches of mahimahi, ono, and blue marlin were made with trolling gear (Table 7). Deep-sea handline also contributed to large catches of these species, and of broadbill, whereas the largest catches of striped marlin were made on flagline gear except in 1976.

GEAR TYPE BY REGION (ALL SPECIES)

For flagline gear, the 2 to 20 nmi zone is generally the most important zone followed by the region beyond 20 nmi (Table 8). The 2 to 20 nmi zone is also the most important for deep-sea handline and trolling gears, but the 0 to 2 nmi zone is the second most important.

GEAR BY REGION AND BY SPECIES

Table 9 represents the data provided in Table 5 so that the impact of different gear types can be compared across regions.

I TABLE 1.--HDAR 1976 DATA -- SPECIES TOTALS.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
TOTAL -- ALL SPECIES	736,975	559,593	\$484,324.18
STRIPED MARLIN	208,984	159,154	\$113,958.40
BLUE MARLIN	191,220	132,088	\$52,304.95
BROADBILL	3,521	3,239	\$2,058.44
SAILFISH	2,343	1,676	\$693.97
MAHIMAHI	139,090	111,353	\$178,400.06
ONO	169,682	135,397	\$127,294.51
SHARK	1,378	9	\$7.40
HAMMERHEAD SHARK	162	0	\$0.00
SHORTBILL SPEARFISH	13,722	11,213	\$7,372.91
BLACK MARLIN	6,873	5,464	\$2,233.54

HDAR 1977 DATA SPECIES TOTALS

TOTAL-- ALL SPECIES	898,345	729,957	\$712,451.76
SWORDFISH	138	138	\$62.20
STRIPED MARLIN	91,336	83,136	\$97,204.89
BLUE MARLIN	366,220	273,485	\$109,515.36
BROADBILL	41,235	41,235	\$67,928.88
SAILFISH	1,407	1,179	\$998.96
MAHIMAHI	150,320	125,042	\$223,798.02
ONO	223,428	189,485	\$203,813.88
SHARK	3,381	868	\$207.15
HAMMERHEAD SHARK	40	0	\$0.00
SHORTBILL SPEARFISH	12,763	9,896	\$6,367.15
BLACK MARLIN	8,077	5,493	\$2,555.27

HDAR 1978 DATA SPECIES TOTALS

TOTAL -- ALL SPECIES	1,089,203	896,493	\$886,309.55
STRIPED MARLIN	147,021	136,166	\$174,652.83
BLUE MARLIN	537,318	428,789	\$206,095.09
BROADBILL	30,143	29,473	\$40,986.20
SAILFISH	697	372	\$223.10
MAHIMAHI	130,762	110,118	\$217,453.04
ONO	194,978	167,351	\$225,262.46
SHARK	20,670	4,004	\$1,497.00
HAMMERHEAD SHARK	1,527	--	--
SHORTBILL SPEARFISH	24,719	19,796	\$19,705.35
BLACK MARLIN	1,368	424	\$434.48

Table 1.--Continued.

HDAR 1979 DATA SPECIES TOTALS			
SPECIES	LBCAUGHT	LBSOLD	REVENUE
TOTAL -- ALL SPECIES	989,871	830,951	\$978,479.00
SWORDFISH	2	--	--
STRIPED MARLIN	111,801	103,291	\$137,676.00
BLUE MARLIN	437,469	350,756	\$176,024.00
BROADBILL	28,938	28,694	\$43,442.00
SAILFISH	2,281	1,607	\$1,214.00
MAHIMAH	174,548	150,982	\$293,749.00
ONO	199,979	172,141	\$305,813.00
SHARK	4,429	1,873	\$717.00
HAMMERHEAD SHARK	2,030	--	--
SHORTBILL SPEARFISH	17,254	13,447	\$15,128.00
BLACK MARLIN	11,140	8,160	\$4,716.00
HDAR 1980 DATA SPECIES TOTALS			
TOTAL -- ALL SPECIES	1,078,117	940,473	\$1,225,984.00
STRIPED MARLIN	66,966	58,710	\$70,173.00
BLUE MARLIN	441,530	382,686	\$190,606.00
BROADBILL	33,024	32,697	\$44,088.00
SAILFISH	957	679	\$598.00
MAHIMAH	238,660	211,617	\$456,019.00
ONO	266,436	238,723	\$452,162.00
SHARK	12,232	745	\$260.00
HAMMERHEAD SHARK	444	345	\$131.00
SHORTBILL SPEARFISH	11,998	9,123	\$8,154.00
BLACK MARLIN	5,870	5,148	\$3,793.00
HDAR 1981 DATA SPECIES TOTALS			
TOTAL -- ALL SPECIES	322,318	277,892	\$447,626.00
STRIPED MARLIN	31,110	26,872	\$32,753.00
BLUE MARLIN	113,884	96,780	\$66,228.00
BROADBILL	1,661	1,607	\$2,769.00
SAILFISH	384	304	\$283.00
MAHIMAH	92,853	82,038	\$194,579.00
ONO	67,134	61,876	\$144,048.00
SHARK	5,235	651	\$307.00
HAMMERHEAD SHARK	200	--	--
SHORTBILL SPEARFISH	6,000	4,273	\$4,584.00
BLACK MARLIN	3,857	3,491	\$2,075.00

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TABLE 2.--HDAR 1976 DATA -- REGION TOTALS.

REGION	LBCAUGHT	LBSOLD	REVENUE
TOTAL -- ALL REGIONS	736,975	559,593	\$484,324.18
0 TO 2 MILES	41,948	32,023	\$29,166.09
2 TO 20 MILES	660,981	494,616	\$422,424.70
NORTHWESTERN H.I.	8,267	8,267	\$6,174.52
BEYOND 20 MILES	25,551	24,494	\$26,314.33
OTHER	228	193	\$244.54

HDAR 1977 DATA REGION TOTALS

TOTAL -- ALL REGIONS	898,345	729,957	\$712,451.76
0 TO 2 MILES	48,982	39,008	\$42,375.78
2 TO 20 MILES	822,283	665,840	\$641,011.84
NORTHWESTERN H.I.	1,687	1,687	\$1,705.68
BEYOND 20 MILES	25,089	23,168	\$27,088.05
OTHER	304	254	\$270.41

HDAR 1978 DATA REGION TOTALS

TOTAL -- ALL REGIONS	1,089,203	896,493	\$886,309.55
0 TO 2 MILES	35,675	24,941	\$30,982.87
2 TO 20 MILES	992,659	812,475	\$789,280.66
NORTHWESTERN H.I.	2,114	2,114	\$5,030.36
BEYOND 20 MILES	56,656	54,864	\$58,450.39
OTHER	2,099	2,099	\$2,565.27

HDAR 1979 DATA REGION TOTALS

TOTAL -- ALL REGIONS	989,871	830,951	\$978,479.00
0 TO 2 MILES	67,606	54,605	\$73,998.00
2 TO 20 MILES	875,476	733,042	\$846,052.00
NORTHWESTERN H.I.	7,361	7,361	\$16,340.00
BEYOND 20 MILES	36,227	32,951	\$36,209.00
OTHER	3,201	2,992	\$5,880.00

HDAR 1980 DATA REGION TOTALS

TOTAL -- ALL REGIONS	1,078,117	940,473	\$1,225,984.00
0 TO 2 MILES	93,738	75,537	\$128,897.00
2 TO 20 MILES	947,910	832,496	\$1,052,276.00
NORTHWESTERN H.I.	4,256	4,256	\$8,159.00
BEYOND 20 MILES	31,844	27,828	\$36,134.00
OTHER	369	356	\$518.00

HDAR 1981 DATA REGION TOTALS

REGION	LBCAUGHT	LBSOLD	REVENUE
TOTAL -- ALL REGIONS	322,318	277,892	\$447,626.00
0 TO 2 MILES	20,136	16,885	\$38,031.00
2 TO 20 MILES	285,332	244,385	\$383,925.00
NORTHWESTERN H.I.	2,988	2,988	\$5,706.00
BEYOND 20 MILES	12,967	12,739	\$18,529.00
OTHER	895	895	\$1,435.00

I TABLE 3.--HDAR 1976 DATA BY REGION FISHED ALL ISLANDS.

SPECIES	LB CAUGHT	LB SOLD	REVENUE
REGION = 0 TO 2 MILES			
STRIPED MARLIN	6,934	4,904	\$2,115.72
BLUE MARLIN	5,033	4,024	\$1,304.80
BROADBILL	103	103	\$51.50
SAILFISH	144	144	\$36.90
MAHIMAH I	6,203	4,517	\$6,399.49
ONO	22,185	18,266	\$19,168.93
SHARK	770	0	\$0.00
HAMMERHEAD SHARK	162	0	\$0.00
SHORTBILL SPEARFISH	414	65	\$88.75
REGION = 2 TO 20 MILES			
STRIPED MARLIN	193,814	146,034	\$101,611.15
BLUE MARLIN	179,815	122,196	\$47,968.82
BROADBILL	3,328	3,046	\$1,961.94
SAILFISH	1,968	1,301	\$545.42
MAHIMAH I	126,665	101,143	\$162,469.02
ONO	137,079	106,748	\$100,349.85
SHARK	608	9	\$7.40
SHORTBILL SPEARFISH	11,228	9,072	\$5,574.56
BLACK MARLIN	6,476	5,067	\$1,936.54
REGION = NORTHWESTERN H.I.			
MAHIMAH I	67	67	\$92.90
ONO	8,200	8,200	\$6,081.62
REGION = BEYOND 20 MILES			
STRIPED MARLIN	8,166	8,166	\$10,156.53
BLUE MARLIN	6,372	5,868	\$3,031.33
BROADBILL	90	90	\$45.00
SAILFISH	231	231	\$111.65
MAHIMAH I	6,053	5,539	\$9,308.15
ONO	2,162	2,127	\$1,655.07
SHORTBILL SPEARFISH	2,080	2,076	\$1,709.60
BLACK MARLIN	397	397	\$297.00
REGION = OTHER			
STRIPED MARLIN	70	50	\$75.00
MAHIMAH I	102	87	\$130.50
ONO	56	56	\$39.04

Table 3.--Continued.

HDAR 1977 DATA BY REGION FISHED ALL ISLANDS

SPECIES	LBCAUGHT	LBSOLD	REVENUE
REGION = 0 TO 2 MILES			
STRIPED MARLIN	622	566	\$290.00
BLUE MARLIN	7,705	4,175	\$1,585.18
SAILFISH	135	135	\$118.75
MAHIMAH	8,346	7,123	\$10,252.61
ONO	30,338	26,717	\$29,998.86
SHARK	1,641	137	\$17.85
HAMMERHEAD SHARK	40	0	\$0.00
SHORTBILL SPEARFISH	155	155	\$112.53
REGION = 2 TO 20 MILES			
SWORDFISH	138	138	\$62.20
STRIPED MARLIN	85,012	76,968	\$89,937.20
BLUE MARLIN	352,389	264,245	\$105,111.07
BROADBILL	39,408	39,408	\$64,900.91
SAILFISH	1,125	904	\$794.71
MAHIMAH	135,729	111,845	\$203,315.26
ONO	188,096	158,176	\$168,806.03
SHARK	1,510	731	\$189.30
SHORTBILL SPEARFISH	12,282	9,415	\$6,030.18
BLACK MARLIN	6,594	4,010	\$1,864.98
REGION = NORTHWESTERN H.I.			
MAHIMAH	20	20	\$30.00
ONO	1,667	1,667	\$1,675.68
REGION = BEYOND 20 MILES			
STRIPED MARLIN	5,652	5,602	\$6,977.69
BLUE MARLIN	6,126	5,065	\$2,819.11
BROADBILL	1,827	1,827	\$3,027.97
SAILFISH	147	140	\$85.50
MAHIMAH	6,225	6,054	\$10,200.15
ONO	3,073	2,671	\$3,062.90
SHARK	230	0	\$0.00
SHORTBILL SPEARFISH	326	326	\$224.44
BLACK MARLIN	1,483	1,483	\$690.29

Table 3.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
REGION = OTHER			
STRIPED MARLIN	50	0	\$0.00
ONO	254	254	\$270.41

HDAR 1978 DATA BY REGION FISHED ALL ISLANDS

REGION = 0 TO 2 MILES

STRIPED MARLIN	633	473	\$333.33
BLUE MARLIN	7,977	4,936	\$2,180.87
BROADBILL	47	47	\$47.00
SAILFISH	70	70	\$70.00
MAHIMAH	5,940	4,963	\$8,292.75
ONO	16,882	14,111	\$19,924.67
SHARK	2,599	341	\$134.25
HAMMERHEAD SHARK	1,527	--	--

REGION = 2 TO 20 MILES

STRIPED MARLIN	127,254	116,721	\$151,807.91
BLUE MARLIN	510,104	405,751	\$195,336.89
BROADBILL	21,426	20,756	\$28,151.40
SAILFISH	627	302	\$153.10
MAHIMAH	120,628	101,185	\$200,905.22
ONO	170,330	145,715	\$193,365.58
SHARK	17,989	3,581	\$1,318.47
SHORTBILL SPEARFISH	22,933	18,040	\$17,807.61
BLACK MARLIN	1,368	424	\$434.48

REGION = NORTHWESTERN H.I.

MAHIMAH	118	118	\$191.52
ONO	1,996	1,996	\$4,838.84

REGION = BEYOND 20 MILES

STRIPED MARLIN	19,134	18,972	\$22,511.59
BLUE MARLIN	19,237	18,102	\$8,577.33
BROADBILL	8,670	8,670	\$12,787.80
MAHIMAH	3,890	3,666	\$7,655.03
ONO	3,857	3,616	\$4,976.62
SHARK	82	82	\$44.28
SHORTBILL SPEARFISH	1,786	1,756	\$1,897.74

Table 3.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
REGION = OTHER			
MAHIMAH I	186	186	\$408.52
ONO	1,913	1,913	\$2,156.75
HDAR 1979 DATA BY REGION FISHED ALL ISLANDS			
REGION = 0 TO 2 MILES			
STRIPED MARLIN	1,275	1,053	\$1,107.00
BLUE MARLIN	19,091	15,627	\$6,607.00
BROADBILL	827	812	\$1,152.00
SAILFISH	152	77	\$56.00
MAHIMAH I	9,408	7,709	\$13,774.00
ONO	32,456	27,915	\$50,124.00
SHARK	1,150	95	\$54.00
HAMMERHEAD SHARK	1,880	--	--
SHORBILL SPEARFISH	1,165	1,115	\$1,023.00
BLACK MARLIN	202	202	\$101.00
REGION = 2 TO 20 MILES			
SWORDFISH	2	--	--
STRIPED MARLIN	103,424	95,311	\$125,999.00
BLUE MARLIN	401,872	320,695	\$162,491.00
BROADBILL	26,829	26,600	\$40,474.00
SAILFISH	1,979	1,380	\$1,030.00
MAHIMAH I	156,746	135,301	\$266,660.00
ONO	156,208	133,453	\$231,509.00
SHARK	2,745	1,244	\$475.00
HAMMERHEAD SHARK	150	--	--
SHORBILL SPEARFISH	15,170	11,562	\$13,134.00
BLACK MARLIN	10,351	7,496	\$4,280.00
REGION = NORTHWESTERN H.I.			
BROADBILL	141	141	\$176.00
MAHIMAH I	30	30	\$30.00
ONO	7,190	7,190	\$16,134.00

Table 3.--Continued.

SPECIES	LB CAUGHT	LB SOLD	REVENUE
REGION = BEYOND 20 MILES			
STRIPED MARLIN	6,705	6,530	\$10,282.00
BLUE MARLIN	16,326	14,434	\$6,926.00
BROADBILL	841	841	\$1,142.00
SAILFISH	150	150	\$128.00
MAHIMAH	7,742	7,344	\$11,984.00
ONO	2,605	2,068	\$4,456.00
SHARK	534	534	\$188.00
SHORBILL SPEARFISH	881	732	\$952.00
BLACK MARLIN	443	318	\$151.00

REGION = OTHER

STRIPED MARLIN	397	397	\$288.00
BLUE MARLIN	180	--	--
BROADBILL	300	300	\$498.00
MAHIMAH	622	598	\$1,301.00
ONO	1,520	1,515	\$3,590.00
SHORBILL SPEARFISH	38	38	\$19.00
BLACK MARLIN	144	144	\$184.00

HDAR 1980 DATA BY REGION FISHED ALL ISLANDS

REGION = 0 TO 2 MILES

STRIPED MARLIN	1,904	1,755	\$2,079.00
BLUE MARLIN	19,012	15,548	\$7,770.00
BROADBILL	603	603	\$869.00
SAILFISH	64	--	--
MAHIMAH	19,084	17,009	\$39,399.00
ONO	44,517	39,475	\$78,005.00
SHARK	7,383	147	\$57.00
HAMMERHEAD SHARK	320	225	\$96.00
SHORBILL SPEARFISH	386	316	\$329.00
BLACK MARLIN	465	459	\$293.00

Table 3.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
REGION = 2 TO 20 MILES			
STRIPED MARLIN	58,570	50,503	\$59,579.00
BLUE MARLIN	410,261	357,376	\$176,816.00
BROADBILL	31,363	31,036	\$41,918.00
SAILFISH	719	505	\$308.00
MAHIMAH I	210,851	186,757	\$400,978.00
ONO	214,999	192,788	\$361,601.00
SHARK	4,680	429	\$136.00
HAMMERHEAD SHARK	124	120	\$35.00
SHORTBILL SPEARFISH	11,158	8,513	\$7,515.00
BLACK MARLIN	5,185	4,469	\$3,390.00
REGION = NORTHWESTERN H.I.			
BLUE MARLIN	173	173	\$96.00
MAHIMAH I	352	352	\$808.00
ONO	3,713	3,713	\$7,245.00
SHORTBILL SPEARFISH	18	18	\$10.00
REGION = BEYOND 20 MILES			
STRIPED MARLIN	6,415	6,375	\$8,417.00
BLUE MARLIN	12,084	9,589	\$5,924.00
BROADBILL	1,058	1,058	\$1,301.00
SAILFISH	174	174	\$290.00
MAHIMAH I	8,277	7,416	\$14,677.00
ONO	3,011	2,551	\$5,048.00
SHARK	169	169	\$67.00
SHORTBILL SPEARFISH	436	276	\$300.00
BLACK MARLIN	220	220	\$110.00
REGION = OTHER			
STRIPED MARLIN	77	77	\$98.00
MAHIMAH I	96	83	\$157.00
ONO	196	196	\$263.00

Table 3.--Continued.

HDAR 1981 DATA BY REGION FISHED ALL ISLANDS

SPECIES	LBCAUGHT	LBSOLD	REVENUE
REGION = 0 TO 2 MILES			
STRIPED MARLIN	501	451	\$833.00
BLUE MARLIN	2,824	2,228	\$1,853.00
BROADBILL	14	14	\$10.00
SAILFISH	21	21	\$15.00
MAHIMAHI	6,983	6,354	\$16,469.00
ONO	8,344	7,442	\$18,634.00
SHARK	1,075	1	\$1.00
SHORTBILL SPEARFISH	54	54	\$24.00
BLACK MARLIN	320	320	\$192.00
REGION = 2 TO 20 MILES			
STRIPED MARLIN	23,616	19,428	\$23,435.00
BLUE MARLIN	107,705	91,197	\$61,678.00
BROADBILL	1,621	1,567	\$2,745.00
SAILFISH	260	180	\$183.00
MAHIMAHI	83,119	73,118	\$171,463.00
ONO	55,295	50,952	\$117,752.00
SHARK	4,160	650	\$306.00
HAMMERHEAD SHARK	200	--	--
SHORTBILL SPEARFISH	5,819	4,122	\$4,480.00
BLACK MARLIN	3,537	3,171	\$1,883.00
REGION = NORTHWESTERN H.I.			
STRIPED MARLIN	38	38	\$22.00
BLUE MARLIN	232	232	\$135.00
MAHIMAHI	135	135	\$499.00
ONO	2,537	2,537	\$5,023.00
SHORTBILL SPEARFISH	46	46	\$27.00
REGION = BEYOND 20 MILES			
STRIPED MARLIN	6,573	6,573	\$7,929.00
BLUE MARLIN	2,845	2,845	\$2,312.00
BROADBILL	26	26	\$14.00
SAILFISH	103	103	\$85.00
MAHIMAHI	2,594	2,409	\$6,103.00
ONO	745	732	\$2,033.00
SHORTBILL SPEARFISH	81	51	\$53.00
REGION = OTHER			
STRIPED MARLIN	382	382	\$534.00
BLUE MARLIN	278	278	\$250.00
MAHIMAHI	22	22	\$45.00
ONO	213	213	\$606.00

I TABLE 4.--HDAR 1976 DATA BY REGION FISHED.

GEAR	LBCAUGHT	LBSOLD	REVENUE
REGION = 0 TO 2 MILES			
FLAGLINE	708	708	\$820.13
DEEP-SEA HANDLINE	5,061	4,558	\$3,542.59
INSHORE HANDLINE	915	842	\$871.27
TROLLING LINE	34,064	25,612	\$23,554.90
OTHER	1,200	303	\$377.20

REGION = 2 TO 20 MILES

FLAGLINE	109,869	109,869	\$120,038.25
DEEP-SEA HANDLINE	80,699	74,748	\$66,338.94
INSHORE HANDLINE	277	277	\$301.31
TROLLING LINE	463,892	303,530	\$225,284.05
OTHER	6,244	6,192	\$10,462.15

REGION = NORTHWESTERN H.I.

DEEP-SEA HANDLINE	8,267	8,267	\$6,174.52
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REGION = BEYOND 20 MILES

FLAGLINE	12,904	12,904	\$14,742.32
DEEP-SEA HANDLINE	2,781	2,751	\$3,080.78
TROLLING LINE	8,734	7,707	\$6,953.21
OTHER	1,132	1,132	\$1,538.02

REGION = OTHER

TROLLING LINE	228	193	\$244.54
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HDAR 1977 DATA BY REGION FISHED

REGION = 0 TO 2 MILES

FLAGLINE	55	55	\$83.25
DEEP-SEA HANDLINE	6,462	5,627	\$5,767.76
INSHORE HANDLINE	900	435	\$565.82
TROLLING LINE	40,426	32,332	\$35,231.55
OTHER	1,139	559	\$727.40

REGION = 2 TO 20 MILES

FLAGLINE	154,789	154,789	\$202,147.78
DEEP-SEA HANDLINE	62,535	57,499	\$57,092.45
INSHORE HANDLINE	1,133	1,078	\$1,149.10
TROLLING LINE	597,374	446,267	\$369,628.41
OTHER	6,452	6,207	\$10,994.10

Table 4.--Continued.

GEAR	LBCAUGHT	LBSOLD	REVENUE
REGION = NORTHWESTERN H.I.			
DEEP-SEA HANDLINE	612	612	\$817.28
TROLLING LINE	1,075	1,075	\$888.40
REGION = BEYOND 20 MILES			
FLAGLINE	11,358	11,358	\$14,211.75
DEEP-SEA HANDLINE	2,458	2,458	\$3,000.07
INSHORE HANDLINE	230	0	\$0.00
TROLLING LINE	8,270	6,579	\$5,327.41
OTHER	2,773	2,773	\$4,548.82
REGION = OTHER			
TROLLING LINE	304	254	\$270.41
HDAR 1978 DATA BY REGION FISHED			
REGION = 0 TO 2 MILES			
FLAGLINE	1,415	1,415	\$2,243.43
DEEP-SEA HANDLINE	1,088	835	\$1,071.05
INSHORE HANDLINE	4,621	4,138	\$4,590.87
TROLLING LINE	26,734	18,506	\$23,069.07
OTHER	1,817	47	\$8.45
REGION = 2 TO 20 MILES			
FLAGLINE	170,487	160,067	\$212,570.06
DEEP-SEA HANDLINE	61,586	57,463	\$67,857.24
INSHORE HANDLINE	87	53	\$81.25
TROLLING LINE	751,680	586,105	\$492,117.31
OTHER	8,819	8,787	\$16,654.80
REGION = NORTHWESTERN H.I.			
DEEP-SEA HANDLINE	2,114	2,114	\$5,030.36
REGION = BEYOND 20 MILES			
FLAGLINE	36,828	36,828	\$47,161.76
DEEP-SEA HANDLINE	2,621	2,571	\$2,035.98
TROLLING LINE	16,693	14,951	\$8,051.27
OTHER	514	514	\$1,201.38

Table 4.--Continued.

GEAR	LB CAUGHT	LB SOLD	REVENUE
REGION = OTHER			
TROLLING LINE	2,085	2,085	\$2,527.60
OTHER	14	14	\$37.67
HDAR 1979 DATA BY REGION FISHED			
REGION = 0 TO 2 MILES			
FLAGLINE	539	539	\$979.00
DEEP-SEA HANDLINE	8,514	8,009	\$11,261.00
INSHORE HANDLINE	427	312	\$488.00
TROLLING LINE	54,365	44,911	\$60,285.00
OTHER	3,761	834	\$985.00
REGION = 2 TO 20 MILES			
FLAGLINE	109,179	109,179	\$157,398.00
DEEP-SEA HANDLINE	67,628	65,005	\$94,727.00
INSHORE HANDLINE	14	--	--
TROLLING LINE	690,987	551,515	\$581,217.00
OTHER	7,668	7,343	\$12,710.00
REGION = NORTHWESTERN H.I.			
DEEP-SEA HANDLINE	237	237	\$309.00
TROLLING LINE	7,124	7,124	\$16,031.00
REGION = BEYOND 20 MILES			
FLAGLINE	8,882	8,882	\$14,053.00
DEEP-SEA HANDLINE	5,784	5,605	\$8,758.00
TROLLING LINE	17,269	14,202	\$7,897.00
OTHER	4,292	4,262	\$5,501.00
REGION = OTHER			
FLAGLINE	1,412	1,388	\$2,155.00
DEEP-SEA HANDLINE	5	--	--
TROLLING LINE	1,747	1,567	\$3,691.00
OTHER	37	37	\$34.00

Table 4.--Continued.

HDAR 1980 DATA BY REGION FISHED			
GEAR	LBCAUGHT	LBSOLD	REVENUE
REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	20,812	15,190	\$23,767.00
INSHORE HANDLINE	1,479	144	\$256.00
TROLLING LINE	70,417	59,779	\$104,502.00
OTHER	1,030	424	\$372.00
REGION = 2 TO 20 MILES			
FLAGLINE	37,148	37,148	\$49,218.00
DEEP-SEA HANDLINE	121,739	116,812	\$189,933.00
INSHORE HANDLINE	13	13	\$35.00
TROLLING LINE	782,555	672,098	\$801,405.00
OTHER	6,455	6,425	\$11,685.00
REGION = NORTHWESTERN H.I.			
DEEP-SEA HANDLINE	18	18	\$10.00
TROLLING LINE	4,238	4,238	\$8,149.00
REGION = BEYOND 20 MILES			
FLAGLINE	8,702	8,634	\$11,327.00
DEEP-SEA HANDLINE	6,956	6,791	\$12,110.00
TROLLING LINE	12,729	8,946	\$7,082.00
OTHER	3,457	3,457	\$5,615.00
REGION = OTHER			
DEEP-SEA HANDLINE	64	64	\$106.00
TROLLING LINE	285	272	\$353.00
OTHER	20	20	\$59.00
HDAR 1981 DATA BY REGION FISHED			
REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	3,301	2,775	\$5,972.00
INSHORE HANDLINE	869	54	\$24.00
TROLLING LINE	15,919	14,009	\$31,846.00
OTHER	47	47	\$189.00

Table 4.--Continued.

GEAR	LBCAUGHT	LBSOLD	REVENUE
REGION = 2 TO 20 MILES			
FLAGLINE	8,067	8,067	\$13,125.00
DEEP-SEA HANDLINE	37,799	33,609	\$69,693.00
TROLLING LINE	236,656	199,899	\$297,042.00
OTHER	2,810	2,810	\$4,065.00
REGION = NORTHWESTERN H.I.			
DEEP-SEA HANDLINE	115	115	\$106.00
TROLLING LINE	2,873	2,873	\$5,600.00
REGION = BEYOND 20 MILES			
FLAGLINE	8,783	8,738	\$10,933.00
DEEP-SEA HANDLINE	1,018	918	\$921.00
TROLLING LINE	2,849	2,766	\$5,691.00
OTHER	317	317	\$984.00
REGION = OTHER			
FLAGLINE	660	660	\$784.00
DEEP-SEA HANDLINE	9	9	\$18.00
TROLLING LINE	226	226	\$633.00

I TABLE 5.--HDAR 1976 DATA BY REGION, GEAR, AND SPECIES.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
REGION = 0 TO 2 MILES GEAR = FLAGLINE			
STRIPED MARLIN	708	708	\$820
REGION = 0 TO 2 MILES GEAR = DEEP-SEA HANDLINE			
STRIPED MARLIN	1,002	1,002	\$181
BLUE MARLIN	490	189	\$38
BROADBILL	103	103	\$52
SAILFISH	46	46	\$14
MAHIMAH I	992	820	\$1,112
ONO	2,418	2,398	\$2,146
SHARK	10	0	\$0
REGION = 0 TO 2 MILES GEAR = INSHORE HANDLINE			
STRIPED MARLIN	79	79	\$98
MAHIMAH I	262	216	\$316
ONO	547	547	\$458
HAMMERHEAD SHARK	27	0	\$0
REGION = 0 TO 2 MILES GEAR = TROLLING LINE			
STRIPED MARLIN	5,145	3,115	\$1,017
BLUE MARLIN	4,543	3,835	\$1,267
SAILFISH	98	98	\$23
MAHIMAH I	4,644	3,178	\$4,595
ONO	19,220	15,321	\$16,565
SHOR TBILL SPEARFISH	414	65	\$89
REGION = 0 TO 2 MILES GEAR = OTHER			
MAHIMAH I	305	303	\$377
SHARK	760	0	\$0
HAMMERHEAD SHARK	135	0	\$0
REGION = 2 TO 20 MILES GEAR = FLAGLINE			
STRIPED MARLIN	67,317	67,317	\$71,689
BLUE MARLIN	14,553	14,553	\$10,739
BROADBILL	429	429	\$174
SAILFISH	529	529	\$253
MAHIMAH I	15,087	15,087	\$27,553
ONO	5,843	5,843	\$5,120
SHOR TBILL SPEARFISH	5,692	5,692	\$4,067
BLACK MARLIN	419	419	\$443

Table 5.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
REGION = 2 TO 20 MILES GEAR = DEEP-SEA HANDLINE			
STRIPED MARLIN	10,895	9,942	\$3,841
BLUE MARLIN	10,748	10,564	\$3,708
BROADBILL	2,356	2,074	\$1,337
SAILFISH	235	159	\$41
MAHIMAHI	22,526	21,703	\$32,091
ONO	32,202	28,908	\$24,969
SHARK	339	0	\$0
SHORTBILL SPEARFISH	395	395	\$189
BLACK MARLIN	1,003	1,003	\$163
REGION = 2 TO 20 MILES GEAR = INSHORE HANDLINE			
MAHIMAHI	107	107	\$137
ONO	170	170	\$164
REGION = 2 TO 20 MILES GEAR = TROLLING LINE			
STRIPED MARLIN	115,602	68,775	\$26,081
BLUE MARLIN	154,514	97,079	\$33,522
BROADBILL	543	543	\$451
SAILFISH	1,204	613	\$251
MAHIMAHI	82,987	58,340	\$92,483
ONO	98,587	71,550	\$69,846
SHARK	260	0	\$0
SHORTBILL SPEARFISH	5,141	2,985	\$1,319
BLACK MARLIN	5,054	3,645	\$1,330
REGION = 2 TO 20 MILES GEAR = OTHER			
MAHIMAHI	5,958	5,906	\$10,205
ONO	277	277	\$250
SHARK	9	9	\$7
REGION = NORTHWESTERN H.I. GEAR = DEEP-SEA HANDLINE			
MAHIMAHI	67	67	\$93
ONO	8,200	8,200	\$6,082
REGION = BEYOND 20 MILES GEAR = FLAGLINE			
STRIPED MARLIN	6,239	6,239	\$8,609
BLUE MARLIN	2,198	2,198	\$1,351
SAILFISH	55	55	\$17
MAHIMAHI	1,374	1,374	\$2,450
ONO	1,693	1,693	\$1,290
SHORTBILL SPEARFISH	1,345	1,345	\$1,026

Table 5.--Continued.

SPECIES	LB CAUGHT	LBS SOLD	REVENUE
REGION = BEYOND 20 MILES GEAR = DEEP-SEA HANDLINE			
STRIPED MARLIN	442	442	\$398
BROADBILL	90	90	\$45
SAILFISH	176	176	\$95
MAHIMAH	1,215	1,215	\$1,741
ONO	204	174	\$138
SHORTBILL SPEARFISH	654	654	\$664
REGION = BEYOND 20 MILES GEAR = TROLLING LINE			
STRIPED MARLIN	1,485	1,485	\$1,150
BLUE MARLIN	4,174	3,670	\$1,681
MAHIMAH	2,332	1,818	\$3,579
ONO	265	260	\$228
SHORTBILL SPEARFISH	81	77	\$19
BLACK MARLIN	397	397	\$297
REGION = BEYOND 20 MILES GEAR = OTHER			
MAHIMAH	1,132	1,132	\$1,538
REGION = OTHER GEAR = TROLLING LINE			
STRIPED MARLIN	70	50	\$75
MAHIMAH	102	87	\$131
ONO	56	56	\$39

I TABLE 5.--HDAR 1977 DATA BY REGION, GEAR, AND SPECIES.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
REGION = 0 TO 2 MILES GEAR = FLAGLINE			
MAHIMAHI	55	55	\$83
REGION = 0 TO 2 MILES GEAR = DEEP-SEA HANDLINE			
BLUE MARLIN	895	534	\$333
MAHIMAHI	1,817	1,757	\$2,607
ONO	3,202	3,202	\$2,810
SHARK	548	134	\$18
REGION = 0 TO 2 MILES GEAR = INSHORE HANDLINE			
MAHIMAHI	226	211	\$369
ONO	224	224	\$196
SHARK	450	0	\$0
REGION = 0 TO 2 MILES GEAR = TROLLING LINE			
STRIPED MARLIN	622	566	\$290
BLUE MARLIN	6,810	3,641	\$1,252
SAILFISH	135	135	\$119
MAHIMAHI	5,955	4,807	\$6,714
ONO	26,730	23,109	\$26,810
SHARK	100	0	\$0
SHORTBILL SPEARFISH	74	74	\$47
REGION = 0 TO 2 MILES GEAR = OTHER			
MAHIMAHI	293	293	\$480
ONO	182	182	\$182
SHARK	543	3	\$0
HAMMERHEAD SHARK	40	0	\$0
SHORTBILL SPEARFISH	81	81	\$66
REGION = 2 TO 20 MILES GEAR = FLAGLINE			
STRIPED MARLIN	64,772	64,772	\$79,657
BLUE MARLIN	22,523	22,523	\$17,834
BROADBILL	35,362	35,362	\$61,388
SAILFISH	620	620	\$626
MAHIMAHI	13,805	13,805	\$27,620
ONO	11,316	11,316	\$10,204
SHORTBILL SPEARFISH	6,133	6,133	\$4,419
BLACK MARLIN	258	258	\$401

Table 5.--Continued.

SPECIES	LB CAUGHT	LB SOLD	REVENUE
REGION = 2 TO 20 MILES GEAR = DEEP-SEA HANDLINE			
STRIPED MARLIN	1,217	1,174	\$1,095
BLUE MARLIN	15,858	13,196	\$5,776
BROADBILL	3,756	3,756	\$3,191
SAILFISH	107	39	\$23
MAHIMAHI	15,462	14,563	\$22,993
ONO	24,237	23,402	\$23,408
SHARK	695	416	\$112
SHORTBILL SPEARFISH	473	396	\$163
BLACK MARLIN	730	557	\$332
REGION = 2 TO 20 MILES GEAR = INSHORE HANDLINE			
STRIPED MARLIN	100	100	\$100
MAHIMAHI	228	228	\$299
ONO	805	750	\$750
REGION = 2 TO 20 MILES GEAR = TROLLING LINE			
SWORDFISH	138	138	\$62
STRIPED MARLIN	18,923	10,922	\$9,086
BLUE MARLIN	314,008	228,526	\$81,502
BROADBILL	290	290	\$323
SAILFISH	376	223	\$133
MAHIMAHI	100,538	77,578	\$141,838
ONO	151,358	122,348	\$134,072
SHARK	461	161	\$32
SHORTBILL SPEARFISH	5,676	2,886	\$1,449
BLACK MARLIN	5,606	3,195	\$1,132
REGION = 2 TO 20 MILES GEAR = OTHER			
SAILFISH	22	22	\$13
MAHIMAHI	5,696	5,671	\$10,564
ONO	380	360	\$372
SHARK	354	154	\$45
REGION = NORTHWESTERN H.I. GEAR = DEEP-SEA HANDLINE			
ONO	612	612	\$817
REGION = NORTHWESTERN H.I. GEAR = TROLLING LINE			
MAHIMAHI	20	20	\$30
ONO	1,055	1,055	\$858

Table 5.--Continued.

SPECIES	LB CAUGHT	LB SOLD	REVENUE
REGION = BEYOND 20 MILES GEAR = FLAGLINE			
STRIPED MARLIN	5,161	5,161	\$6,603
BLUE MARLIN	2,103	2,103	\$1,636
BROADBILL	1,603	1,603	\$2,830
SAILFISH	114	114	\$69
MAHIMAH	1,007	1,007	\$1,761
ONO	868	868	\$963
SHORTBILL SPEARFISH	297	297	\$175
BLACK MARLIN	205	205	\$174
REGION = BEYOND 20 MILES GEAR = DEEP-SEA HANDLINE			
STRIPED MARLIN	110	110	\$105
BROADBILL	224	224	\$198
SAILFISH	26	26	\$17
MAHIMAH	971	971	\$1,598
ONO	1,127	1,127	\$1,082
REGION = BEYOND 20 MILES GEAR = INSHORE HANDLINE			
SHARK	230	0	\$0
REGION = BEYOND 20 MILES GEAR = TROLLING LINE			
STRIPED MARLIN	381	331	\$270
BLUE MARLIN	4,023	2,962	\$1,183
SAILFISH	7	0	\$0
MAHIMAH	1,482	1,311	\$2,299
ONO	1,070	668	\$1,011
SHORTBILL SPEARFISH	29	29	\$49
BLACK MARLIN	1,278	1,278	\$516
REGION = BEYOND 20 MILES GEAR = OTHER			
MAHIMAH	2,765	2,765	\$4,543
ONO	8	8	\$6
REGION = OTHER GEAR = TROLLING LINE			
STRIPED MARLIN	50	0	\$0
ONO	254	254	\$270

I TABLE 5.--HDAR 1978 DATA BY REGION, GEAR, AND SPECIES.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
REGION = 0 TO 2 MILES GEAR = FLAGLINE			
MAHIMAHI	881	881	\$1,469
ONO	534	534	\$775
REGION = 0 TO 2 MILES GEAR = DEEP-SEA HANDLINE			
SAILFISH	70	70	\$70
MAHIMAHI	307	307	\$486
ONO	411	386	\$490
SHARK	300	72	\$25
REGION = 0 TO 2 MILES GEAR = INSHORE HANDLINE			
STRIPED MARLIN	136	136	\$54
BLUE MARLIN	1,114	1,114	\$465
BROADBILL	47	47	\$47
MAHIMAHI	850	787	\$1,424
ONO	1,943	1,888	\$2,529
SHARK	531	166	\$72
REGION = 0 TO 2 MILES GEAR = TROLLING LINE			
STRIPED MARLIN	497	337	\$279
BLUE MARLIN	6,863	3,822	\$1,716
MAHIMAHI	3,898	2,984	\$4,908
ONO	13,951	11,303	\$16,131
SHARK	1,525	60	\$35
REGION = 0 TO 2 MILES GEAR = OTHER			
MAHIMAHI	4	4	\$6
ONO	43	0	\$0
SHARK	243	43	\$2
HAMMERHEAD SHARK	1,527	--	--
REGION = 2 TO 20 MILES GEAR = FLAGLINE			
STRIPED MARLIN	87,889	87,889	\$124,052
BLUE MARLIN	34,622	34,622	\$32,643
BROADBILL	11,952	11,282	\$17,181
SAILFISH	49	49	\$37
MAHIMAHI	7,449	7,449	\$17,480
ONO	7,722	7,722	\$9,701
SHARK	11,085	1,335	\$453
SHORTBILL SPEARFISH	9,719	9,719	\$11,023

Table 5.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
REGION = 2 TO 20 MILES GEAR = DEEP-SEA HANDLINE			
STRIPED MARLIN	2,613	2,287	\$2,280
BLUE MARLIN	11,156	10,809	\$4,945
BROADBILL	8,916	8,916	\$10,235
SAILFISH	43	43	\$15
MAHIMAH I	12,654	12,111	\$22,111
ONO	21,887	21,438	\$27,124
SHARK	3,740	1,282	\$472
SHORTBILL SPEARFISH	577	577	\$676
REGION = 2 TO 20 MILES GEAR = INSHORE HANDLINE			
MAHIMAH I	19	19	\$29
ONO	68	34	\$53
REGION = 2 TO 20 MILES GEAR = TROLLING LINE			
STRIPED MARLIN	36,752	26,545	\$25,476
BLUE MARLIN	464,326	360,320	\$157,749
BROADBILL	558	558	\$736
SAILFISH	535	210	\$101
MAHIMAH I	91,774	72,874	\$144,685
ONO	140,566	116,466	\$156,433
SHARK	3,164	964	\$393
SHORTBILL SPEARFISH	12,637	7,744	\$6,109
BLACK MARLIN	1,368	424	\$434
REGION = 2 TO 20 MILES GEAR = OTHER			
MAHIMAH I	8,732	8,732	\$16,600
ONO	87	55	\$55
REGION = NORTHWESTERN H.I. GEAR = DEEP-SEA HANDLINE			
MAHIMAH I	118	118	\$192
ONO	1,996	1,996	\$4,839
REGION = BEYOND 20 MILES GEAR = FLAGLINE			
STRIPED MARLIN	17,382	17,382	\$21,314
BLUE MARLIN	5,458	5,458	\$4,536
BROADBILL	8,530	8,530	\$12,683
MAHIMAH I	2,092	2,092	\$4,336
ONO	1,917	1,917	\$2,677
SHORTBILL SPEARFISH	1,449	1,449	\$1,616

Table 5.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
REGION = BEYOND 20 MILES GEAR = DEEP-SEA HANDLINE			
STRIPED MARLIN	585	545	\$409
BLUE MARLIN	988	988	\$280
BROADBILL	140	140	\$105
MAHIMAHI	512	512	\$843
ONO	314	304	\$354
SHARK	82	82	\$44
REGION = BEYOND 20 MILES GEAR = TROLLING LINE			
STRIPED MARLIN	1,167	1,045	\$789
BLUE MARLIN	12,791	11,656	\$3,761
MAHIMAHI	772	548	\$1,274
ONO	1,626	1,395	\$1,945
SHORTBILL SPEARFISH	337	307	\$282
REGION = BEYOND 20 MILES GEAR = OTHER			
MAHIMAHI	514	514	\$1,201
REGION = OTHER GEAR = TROLLING LINE			
MAHIMAHI	172	172	\$371
ONO	1,913	1,913	\$2,157
REGION = OTHER GEAR = OTHER			
MAHIMAHI	14	14	\$38

I TABLE 5.--HDAR 1979 DATA BY REGION, GEAR, AND SPECIES.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
REGION = 0 TO 2 MILES GEAR = FLAGLINE			
MAHIMAHI	510	510	\$920
ONO	29	29	\$59
REGION = 0 TO 2 MILES GEAR = DEEP-SEA HANDLINE			
STRIPED MARLIN	286	216	\$115
BLUE MARLIN	705	705	\$436
BROADBILL	827	812	\$1,152
MAHIMAHI	2,314	2,061	\$3,261
ONO	4,135	3,968	\$6,140
SHORTBILL SPEARFISH	45	45	\$56
BLACK MARLIN	202	202	\$101
REGION = 0 TO 2 MILES GEAR = INSHORE HANDLINE			
MAHIMAHI	87	80	\$127
SHARK	58	--	--
REGION = 0 TO 2 MILES GEAR = TROLLING LINE			
STRIPED MARLIN	989	837	\$992
BLUE MARLIN	18,386	14,922	\$6,171
SAILFISH	152	77	\$56
MAHIMAHI	6,399	4,960	\$9,263
ONO	27,982	23,658	\$43,499
SHARK	66	66	\$6
SHORTBILL SPEARFISH	391	391	\$298
REGION = 0 TO 2 MILES GEAR = OTHER			
MAHIMAHI	98	98	\$203
ONO	28	28	\$65
SHARK	1,026	29	\$48
HAMMERHEAD SHARK	1,880	--	--
SHORTBILL SPEARFISH	729	679	\$669

Table 5.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
REGION = 2 TO 20 MILES GEAR = FLAGLINE			
STRIPED MARLIN	66,510	66,510	\$94,880
BLUE MARLIN	13,747	13,747	\$14,536
BROADBILL	14,278	14,278	\$23,566
SAILFISH	677	677	\$597
MAHIMAHI	6,508	6,508	\$13,655
ONO	2,741	2,741	\$5,247
SHARK	871	871	\$397
SHORTBILL SPEARFISH	3,747	3,747	\$4,422
BLACK MARLIN	100	100	\$98
REGION = 2 TO 20 MILES GEAR = DEEP-SEA HANDLINE			
SWORDFISH	2	--	--
STRIPED MARLIN	4,474	4,364	\$5,493
BLUE MARLIN	12,508	12,211	\$8,980
BROADBILL	12,201	12,201	\$16,812
SAILFISH	99	99	\$82
MAHIMAHI	19,285	18,307	\$34,539
ONO	16,826	16,148	\$27,170
SHARK	190	--	--
SHORTBILL SPEARFISH	410	390	\$329
BLACK MARLIN	1,633	1,285	\$1,322
REGION = 2 TO 20 MILES GEAR = INSHORE HANDLINE			
MAHIMAHI	14	--	--
REGION = 2 TO 20 MILES GEAR = TROLLING LINE			
STRIPED MARLIN	32,110	24,362	\$25,454
BLUE MARLIN	374,958	294,078	\$138,877
BROADBILL	350	121	\$96
SAILFISH	1,203	604	\$351
MAHIMAHI	124,447	104,039	\$206,138
ONO	136,589	114,537	\$199,021
SHARK	1,549	238	\$37
HAMMERHEAD SHARK	150	--	--
SHORTBILL SPEARFISH	11,013	7,425	\$8,383
BLACK MARLIN	8,618	6,111	\$2,860

Table 5.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
REGION = 2 TO 20 MILES GEAR = OTHER			
STRIPED MARLIN	330	75	\$172
BLUE MARLIN	659	659	\$98
MAHIMAHI	6,492	6,447	\$12,328
ONO	52	27	\$71
SHARK	135	135	\$41
REGION = NORTHWESTERN H.I. GEAR = DEEP-SEA HANDLINE			
BROADBILL	141	141	\$176
ONO	96	96	\$133
REGION = NORTHWESTERN H.I. GEAR = TROLLING LINE			
MAHIMAHI	30	30	\$30
ONO	7,094	7,094	\$16,001
REGION = BEYOND 20 MILES GEAR = FLAGLINE			
STRIPED MARLIN	4,954	4,954	\$8,903
BLUE MARLIN	1,481	1,481	\$1,507
BROADBILL	220	220	\$330
SAILFISH	73	73	\$42
MAHIMAHI	553	553	\$1,054
ONO	445	445	\$1,206
SHARK	534	534	\$188
SHORTBILL SPEARFISH	622	622	\$823
REGION = BEYOND 20 MILES GEAR = DEEP-SEA HANDLINE			
STRIPED MARLIN	644	644	\$781
BLUE MARLIN	1,569	1,464	\$1,267
BROADBILL	621	621	\$812
SAILFISH	77	77	\$86
MAHIMAHI	2,040	2,040	\$3,891
ONO	833	759	\$1,921
REGION = BEYOND 20 MILES GEAR = TROLLING LINE			
STRIPED MARLIN	875	700	\$445
BLUE MARLIN	13,042	11,255	\$4,082
MAHIMAHI	1,395	997	\$1,834
ONO	1,285	822	\$1,256
SHORTBILL SPEARFISH	229	110	\$129
BLACK MARLIN	443	318	\$151

Table 5.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
REGION = BEYOND 20 MILES GEAR = OTHER			
STRIPED MARLIN	232	232	\$153
BLUE MARLIN	234	234	\$70
MAHIMAHI	3,754	3,754	\$5,205
ONO	42	42	\$73
SHORTBILL SPEARFISH	30	--	--
REGION = OTHER GEAR = FLAGLINE			
STRIPED MARLIN	397	397	\$288
BROADBILL	300	300	\$498
MAHIMAHI	274	250	\$620
ONO	297	297	\$565
BLACK MARLIN	144	144	\$184
REGION = OTHER GEAR = DEEP-SEA HANDLINE			
ONO	5	--	--
REGION = OTHER GEAR = TROLLING LINE			
BLUE MARLIN	180	--	--
MAHIMAHI	311	311	\$647
ONO	1,218	1,218	\$3,025
SHORTBILL SPEARFISH	38	38	\$19
REGION = OTHER GEAR = OTHER			
MAHIMAHI	37	37	\$34

I TABLE 5.--HDAR 1980 DATA BY REGION, GEAR, AND SPECIES.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
REGION = 0 TO 2 MILES GEAR = DEEP-SEA HANDLINE			
STRIPED MARLIN	449	449	\$337
BLUE MARLIN	4,634	3,910	\$1,755
BROADBILL	445	445	\$632
MAHIMAHI	5,475	5,268	\$11,670
ONO	5,035	5,010	\$9,239
SHARK	4,666	--	--
SHORTBILL SPEARFISH	108	108	\$134
REGION = 0 TO 2 MILES GEAR = INSHORE HANDLINE			
MAHIMAHI	92	81	\$205
ONO	48	44	\$37
SHARK	1,333	13	\$6
SHORTBILL SPEARFISH	6	6	\$8
REGION = 0 TO 2 MILES GEAR = TROLLING LINE			
STRIPED MARLIN	1,455	1,306	\$1,742
BLUE MARLIN	14,378	11,638	\$6,015
BROADBILL	158	158	\$237
SAILFISH	64	--	--
MAHIMAHI	13,451	11,594	\$27,424
ONO	39,327	34,314	\$68,568
SHARK	763	113	\$39
HAMMERHEAD SHARK	95	--	--
SHORTBILL SPEARFISH	271	201	\$186
BLACK MARLIN	455	455	\$291
REGION = 0 TO 2 MILES GEAR = OTHER			
MAHIMAHI	66	66	\$100
ONO	107	107	\$161
SHARK	621	21	\$12
HAMMERHEAD SHARK	225	225	\$96
SHORTBILL SPEARFISH	1	1	\$1
BLACK MARLIN	10	4	\$2
REGION = 2 TO 20 MILES GEAR = FLAGLINE			
STRIPED MARLIN	19,875	19,875	\$22,815
BLUE MARLIN	6,870	6,870	\$5,920
BROADBILL	489	489	\$1,028
MAHIMAHI	7,562	7,562	\$15,981
ONO	2,014	2,014	\$3,295
SHARK	101	101	\$35
SHORTBILL SPEARFISH	237	237	\$144

Table 5.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
REGION = BEYOND 20 MILES GEAR = FLAGLINE			
STRIPED MARLIN	4,539	4,539	\$5,325
BLUE MARLIN	1,834	1,834	\$1,760
BROADBILL	206	206	\$210
MAHIMAH I	1,290	1,222	\$2,546
ONO	581	581	\$1,307
SHARK	169	169	\$67
SHORTBILL SPEARFISH	83	83	\$112
REGION = BEYOND 20 MILES GEAR = DEEP-SEA HANDLINE			
STRIPED MARLIN	1,390	1,390	\$2,596
BLUE MARLIN	1,190	1,190	\$1,142
BROADBILL	852	852	\$1,091
SAILFISH	174	174	\$290
MAHIMAH I	1,854	1,719	\$4,167
ONO	1,470	1,440	\$2,814
SHORTBILL SPEARFISH	26	26	\$10
REGION = BEYOND 20 MILES GEAR = TROLLING LINE			
STRIPED MARLIN	486	446	\$496
BLUE MARLIN	9,060	6,565	\$3,022
MAHIMAH I	1,676	1,018	\$2,349
ONO	960	530	\$927
SHORTBILL SPEARFISH	327	167	\$178
BLACK MARLIN	220	220	\$110
REGION = BEYOND 20 MILES GEAR = OTHER			
MAHIMAH I	3,457	3,457	\$5,615
REGION = OTHER GEAR = DEEP-SEA HANDLINE			
MAHIMAH I	6	6	\$9
ONO	58	58	\$97
REGION = OTHER GEAR = TROLLING LINE			
STRIPED MARLIN	77	77	\$98
MAHIMAH I	70	57	\$89
ONO	138	138	\$166
REGION = OTHER GEAR = OTHER			
MAHIMAH I	20	20	\$59

Table 5.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
REGION = 2 TO 20 MILES GEAR = DEEP-SEA HANDLINE			
STRIPED MARLIN	2,466	2,367	\$3,085
BLUE MARLIN	20,565	18,974	\$10,971
BROADBILL	29,510	29,183	\$39,393
SAILFISH	273	233	\$126
MAHIMAH I	33,537	32,508	\$71,323
ONO	33,780	32,694	\$64,184
SHARK	591	241	\$90
SHORTBILL SPEARFISH	490	363	\$314
BLACK MARLIN	527	249	\$447
REGION = 2 TO 20 MILES GEAR = INSHORE HANDLINE			
MAHIMAH I	13	13	\$35
REGION = 2 TO 20 MILES GEAR = TROLLING LINE			
STRIPED MARLIN	36,229	28,261	\$33,679
BLUE MARLIN	382,176	330,882	\$159,730
BROADBILL	874	874	\$982
SAILFISH	446	272	\$182
MAHIMAH I	164,732	141,667	\$303,092
ONO	178,897	157,802	\$293,694
SHARK	3,988	87	\$11
HAMMERHEAD SHARK	124	120	\$35
SHORTBILL SPEARFISH	10,431	7,913	\$7,057
BLACK MARLIN	4,658	4,220	\$2,943
REGION = 2 TO 20 MILES GEAR = OTHER			
BLUE MARLIN	650	650	\$195
BROADBILL	490	490	\$515
MAHIMAH I	5,007	5,007	\$10,547
ONO	308	278	\$428
REGION = NORTHWESTERN H.I. GEAR = DEEP-SEA HANDLINE			
SHORTBILL SPEARFISH	18	18	\$10
REGION = NORTHWESTERN H.I. GEAR = TROLLING LINE			
BLUE MARLIN	173	173	\$96
MAHIMAH I	352	352	\$808
ONO	3,713	3,713	\$7,245

I TABLE 5.--HDAR 1981 DATA BY REGION, GEAR, AND SPECIES.

SPECIES	LB CAUGHT	LB SOLD	REVENUE
REGION = 0 TO 2 MILES GEAR = DEEP-SEA HANDLINE			
STRIPED MARLIN	47	47	\$47
BLUE MARLIN	546	430	\$561
BROADBILL	14	14	\$10
SAILFISH	21	21	\$15
MAHIMAH	1,490	1,420	\$3,621
ONO	902	843	\$1,718
SHARK	281	--	--
REGION = 0 TO 2 MILES GEAR = INSHORE HANDLINE			
ONO	22	--	--
SHARK	793	--	--
SHORBILL SPEARFISH	54	54	\$24
REGION = 0 TO 2 MILES GEAR = TROLLING LINE			
STRIPED MARLIN	454	404	\$786
BLUE MARLIN	2,278	1,798	\$1,292
MAHIMAH	5,447	4,888	\$12,660
ONO	7,420	6,599	\$16,916
BLACK MARLIN	320	320	\$192
REGION = 0 TO 2 MILES GEAR = OTHER			
MAHIMAH	46	46	\$188
SHARK	1	1	\$1
REGION = 2 TO 20 MILES GEAR = FLAGLINE			
STRIPED MARLIN	4,773	4,773	\$5,838
BLUE MARLIN	384	384	\$393
MAHIMAH	2,514	2,514	\$6,027
ONO	329	329	\$817
SHORBILL SPEARFISH	67	67	\$50
REGION = 2 TO 20 MILES GEAR = DEEP-SEA HANDLINE			
STRIPED MARLIN	588	585	\$665
BLUE MARLIN	5,432	4,852	\$5,009
BROADBILL	1,621	1,567	\$2,745
MAHIMAH	13,287	13,026	\$32,248
ONO	12,705	12,424	\$28,321
SHARK	3,610	650	\$306
SHORBILL SPEARFISH	556	505	\$399

Table 5.--Continued.

SPECIES	LB CAUGHT	LBS SOLD	REVENUE
REGION = 2 TO 20 MILES GEAR = TROLLING LINE			
STRIPED MARLIN	18,255	14,070	\$16,932
BLUE MARLIN	101,889	85,961	\$56,276
SAILFISH	260	180	\$183
MAHIMAH	64,521	54,781	\$129,142
ONO	42,248	38,186	\$88,595
SHARK	550	--	--
HAMMERHEAD SHARK	200	--	--
SHORTBILL SPEARFISH	5,196	3,550	\$4,031
BLACK MARLIN	3,537	3,171	\$1,883
REGION = 2 TO 20 MILES GEAR = OTHER			
MAHIMAH	2,797	2,797	\$4,046
ONO	13	13	\$19
REGION = NORTHWESTERN H.I. GEAR = DEEP-SEA HANDLINE			
STRIPED MARLIN	38	38	\$22
MAHIMAH	31	31	\$57
SHORTBILL SPEARFISH	46	46	\$27
REGION = NORTHWESTERN H.I. GEAR = TROLLING LINE			
BLUE MARLIN	232	232	\$135
MAHIMAH	104	104	\$442
ONO	2,537	2,537	\$5,023
REGION = BEYOND 20 MILES GEAR = FLAGLINE			
STRIPED MARLIN	6,504	6,504	\$7,862
BLUE MARLIN	1,393	1,393	\$1,250
BROADBILL	26	26	\$14
SAILFISH	103	103	\$85
MAHIMAH	589	544	\$1,308
ONO	168	168	\$414
REGION = BEYOND 20 MILES GEAR = DEEP-SEA HANDLINE			
BLUE MARLIN	490	490	\$122
MAHIMAH	435	335	\$619
ONO	93	93	\$180

Table 5.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
REGION = BEYOND 20 MILES GEAR = TROLLING LINE			
STRIPED MARLIN	69	69	\$67
BLUE MARLIN	962	962	\$940
MAHIMAHI	1,253	1,213	\$3,192
ONO	484	471	\$1,439
SHORTBILL SPEARFISH	81	51	\$53
REGION = BEYOND 20 MILES GEAR = OTHER			
MAHIMAHI	317	317	\$984
REGION = OTHER GEAR = FLAGLINE			
STRIPED MARLIN	382	382	\$534
BLUE MARLIN	278	278	\$250
REGION = OTHER GEAR = DEEP-SEA HANDLINE			
MAHIMAHI	9	9	\$18
REGION = OTHER GEAR = TROLLING LINE			
MAHIMAHI	13	13	\$27
ONO	213	213	\$606

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TABLE 6.--HDAR 1976 DATA -- GEAR TOTALS.

GEAR	LB CAUGHT	LBSOLD	REVENUE
TOTAL -- ALL GEAR	736,975	559,593	\$484,324.18
FLAGLINE	123,481	123,481	\$135,600.70
DEEP-SEA HANDLINE	96,808	90,324	\$79,136.83
INSHORE HANDLINE	1,192	1,119	\$1,172.58
TROLLING LINE	506,918	337,042	\$256,036.70
OTHER	8,576	7,627	\$12,377.37

HDAR 1977 DATA GEAR TOTALS

TOTAL -- ALL GEAR	898,345	729,957	\$712,451.76
FLAGLINE	166,202	166,202	\$216,442.78
DEEP-SEA HANDLINE	72,067	66,196	\$66,677.56
INSHORE HANDLINE	2,263	1,513	\$1,714.92
TROLLING LINE	647,449	486,507	\$411,346.18
OTHER	10,364	9,539	\$16,270.32

HDAR 1978 DATA GEAR TOTALS

TOTAL -- ALL GEAR	1,089,203	896,493	\$886,309.55
FLAGLINE	208,730	198,310	\$261,975.25
DEEP-SEA HANDLINE	67,409	62,983	\$75,994.63
INSHORE HANDLINE	4,708	4,191	\$4,672.12
TROLLING LINE	797,192	621,647	\$525,765.25
OTHER	11,164	9,362	\$17,902.30

HDAR 1979 DATA GEAR TOTALS

TOTAL -- ALL GEAR	989,871	830,951	\$978,479.00
FLAGLINE	120,012	119,988	\$174,585.00
DEEP-SEA HANDLINE	82,168	78,856	\$115,055.00
INSHORE HANDLINE	441	312	\$488.00
TROLLING LINE	771,492	619,319	\$669,121.00
OTHER	15,758	12,476	\$19,230.00

HDAR 1980 DATA GEAR TOTALS

TOTAL -- ALL GEAR	1,078,117	940,473	\$1,225,984.00
FLAGLINE	45,850	45,782	\$60,545.00
DEEP-SEA HANDLINE	149,589	138,875	\$225,926.00
INSHORE HANDLINE	1,492	157	\$291.00
TROLLING LINE	870,224	745,333	\$921,491.00
OTHER	10,962	10,326	\$17,731.00

Table 6.--Continued.

GEAR	HDAR 1981 DATA	GEAR TOTALS	
	LBCAUGHT	LBSOLD	REVENUE
TOTAL -- ALL GEAR	322,318	277,892	\$447,626.00
FLAGLINE	17,510	17,465	\$24,842.00
DEEP-SEA HANDLINE	42,242	37,426	\$76,710.00
INSHORE HANDLINE	869	54	\$24.00
TROLLING LINE	258,523	219,773	\$340,812.00
OTHER	3,174	3,174	\$5,238.00

I TABLE 7.--HDAR 1976 DATA BY GEAR AND SPECIES.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
GEAR = FLAGLINE			
STRIPED MARLIN	74,264	74,264	\$81,118
BLUE MARLIN	16,751	16,751	\$12,089
BROADBILL	429	429	\$174
SAILFISH	584	584	\$270
MAHIMAH I	16,461	16,461	\$30,004
ONO	7,536	7,536	\$6,410
SHORTBILL SPEARFISH	7,037	7,037	\$5,093
BLACK MARLIN	419	419	\$443
GEAR = DEEP-SEA HANDLINE			
STRIPED MARLIN	12,339	11,386	\$4,420
BLUE MARLIN	11,238	10,753	\$3,746
BROADBILL	2,549	2,267	\$1,433
SAILFISH	457	381	\$150
MAHIMAH I	24,800	23,805	\$35,036
ONO	43,024	39,680	\$33,335
SHARK	349	0	\$0
SHORTBILL SPEARFISH	1,049	1,049	\$853
BLACK MARLIN	1,003	1,003	\$163
GEAR = INSHORE HANDLINE			
STRIPED MARLIN	79	79	\$98
MAHIMAH I	369	323	\$452
ONO	717	717	\$622
HAMMERHEAD SHARK	27	0	\$0
GEAR = TROLLING LINE			
STRIPED MARLIN	122,302	73,425	\$28,323
BLUE MARLIN	163,231	104,584	\$36,470
BROADBILL	543	543	\$451
SAILFISH	1,302	711	\$274
MAHIMAH I	90,065	63,423	\$100,788
ONO	118,128	87,187	\$86,678
SHARK	260	0	\$0
SHORTBILL SPEARFISH	5,636	3,127	\$1,427
BLACK MARLIN	5,451	4,042	\$1,627
GEAR = OTHER			
MAHIMAH I	7,395	7,341	\$12,120
ONO	277	277	\$250
SHARK	769	9	\$7
HAMMERHEAD SHARK	135	0	\$0

I TABLE 7.--HDAR 1977 DATA BY GEAR AND SPECIES.

SPECIES	LB CAUGHT	LBS SOLD	REVENUE
GEAR = FLAGLINE			
STRIPED MARLIN	69,933	69,933	\$86,260
BLUE MARLIN	24,626	24,626	\$19,470
BROADBILL	36,965	36,965	\$64,218
SAILFISH	734	734	\$694
MAHIMAH I	14,867	14,867	\$29,464
ONO	12,184	12,184	\$11,168
SHORTBILL SPEARFISH	6,430	6,430	\$4,594
BLACK MARLIN	463	463	\$575
GEAR = DEEP-SEA HANDLINE			
STRIPED MARLIN	1,327	1,284	\$1,199
BLUE MARLIN	16,753	13,730	\$6,109
BROADBILL	3,980	3,980	\$3,389
SAILFISH	133	65	\$40
MAHIMAH I	18,250	17,291	\$27,198
ONO	29,178	28,343	\$28,118
SHARK	1,243	550	\$130
SHORTBILL SPEARFISH	473	396	\$163
BLACK MARLIN	730	557	\$332
GEAR = INSHORE HANDLINE			
STRIPED MARLIN	100	100	\$100
MAHIMAH I	454	439	\$669
ONO	1,029	974	\$946
SHARK	680	0	\$0
GEAR = TROLLING LINE			
SWORDFISH	138	138	\$62
STRIPED MARLIN	19,976	11,819	\$9,646
BLUE MARLIN	324,841	235,129	\$83,937
BROADBILL	290	290	\$323
SAILFISH	518	358	\$251
MAHIMAH I	107,995	83,716	\$150,881
ONO	180,467	147,434	\$163,022
SHARK	561	161	\$32
SHORTBILL SPEARFISH	5,779	2,989	\$1,545
BLACK MARLIN	6,884	4,473	\$1,648

Table 7.--Continued.

SPECIES	LB CAUGHT	LB SOLD	REVENUE
	GEAR = OTHER		
SAILFISH	22	22	\$13
MAHIMAH	8,754	8,729	\$15,587
ONO	570	550	\$560
SHARK	897	157	\$45
HAMMERHEAD SHARK	40	0	\$0
SHORTBILL SPEARFISH	81	81	\$66

I TABLE 7.--HDAR 1978 DATA BY GEAR AND SPECIES.

SPECIES	LB CAUGHT	LB SOLD	REVENUE
GEAR = FLAGLINE			
STRIPED MARLIN	105,271	105,271	\$145,366
BLUE MARLIN	40,080	40,080	\$37,180
BROADBILL	20,482	19,812	\$29,864
SAILFISH	49	49	\$37
MAHIMAH I	10,422	10,422	\$23,285
ONO	10,173	10,173	\$13,153
SHARK	11,085	1,335	\$453
SHORTBILL SPEARFISH	11,168	11,168	\$12,639
GEAR = DEEP-SEA HANDLINE			
STRIPED MARLIN	3,198	2,832	\$2,689
BLUE MARLIN	12,144	11,797	\$5,225
BROADBILL	9,056	9,056	\$10,340
SAILFISH	113	113	\$85
MAHIMAH I	13,591	13,048	\$23,632
ONO	24,608	24,124	\$32,807
SHARK	4,122	1,436	\$542
SHORTBILL SPEARFISH	577	577	\$676
GEAR = INSHORE HANDLINE			
STRIPED MARLIN	136	136	\$54
BLUE MARLIN	1,114	1,114	\$465
BROADBILL	47	47	\$47
MAHIMAH I	869	806	\$1,453
ONO	2,011	1,922	\$2,581
SHARK	531	166	\$72
GEAR = TROLLING LINE			
STRIPED MARLIN	38,416	27,927	\$26,543
BLUE MARLIN	483,980	375,798	\$163,226
BROADBILL	558	558	\$736
SAILFISH	535	210	\$101
MAHIMAH I	96,616	76,578	\$151,238
ONO	158,056	131,077	\$176,667
SHARK	4,689	1,024	\$428
SHORTBILL SPEARFISH	12,974	8,051	\$6,391
BLACK MARLIN	1,368	424	\$434
GEAR = OTHER			
MAHIMAH I	9,264	9,264	\$17,845
ONO	130	55	\$55
SHARK	243	43	\$2
HAMMERHEAD SHARK	1,527	--	--

I TABLE 7.--HDAR 1979 DATA BY GEAR AND SPECIES.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
GEAR = FLAGLINE			
STRIPED MARLIN	71,861	71,861	\$104,071
BLUE MARLIN	15,228	15,228	\$16,043
BROADBILL	14,798	14,798	\$24,394
SAILFISH	750	750	\$639
MAHIMAHI	7,845	7,821	\$16,249
ONO	3,512	3,512	\$7,077
SHARK	1,405	1,405	\$585
SHORTBILL SPEARFISH	4,369	4,369	\$5,245
BLACK MARLIN	244	244	\$282
GEAR = DEEP-SEA HANDLINE			
SWORDFISH	2	--	--
STRIPED MARLIN	5,404	5,224	\$6,389
BLUE MARLIN	14,782	14,380	\$10,683
BROADBILL	13,790	13,775	\$18,952
SAILFISH	176	176	\$168
MAHIMAHI	23,639	22,408	\$41,691
ONO	21,895	20,971	\$35,364
SHARK	190	--	--
SHORTBILL SPEARFISH	455	435	\$385
BLACK MARLIN	1,835	1,487	\$1,423
GEAR = INSHORE HANDLINE			
MAHIMAHI	101	80	\$127
ONO	282	232	\$361
SHARK	58	--	--
GEAR = TROLLING LINE			
STRIPED MARLIN	33,974	25,899	\$26,891
BLUE MARLIN	406,566	320,255	\$149,130
BROADBILL	350	121	\$96
SAILFISH	1,355	681	\$407
MAHIMAHI	132,582	110,337	\$217,912
ONO	174,168	147,329	\$262,802
SHARK	1,615	304	\$43
HAMMERHEAD SHARK	150	--	--
SHORTBILL SPEARFISH	11,671	7,964	\$8,829
BLACK MARLIN	9,061	6,429	\$3,011

Table 7.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
	GEAR = OTHER		
STRIPED MARLIN	562	307	\$325
BLUE MARLIN	893	893	\$168
MAHIMAH	10,381	10,336	\$17,770
ONO	122	97	\$209
SHARK	1,161	164	\$89
HAMMERHEAD SHARK	1,880	--	--
SHORTBILL SPEARFISH	759	679	\$669

I TABLE 7.--HDAR 1980 DATA BY GEAR AND SPECIES.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
GEAR = FLAGLINE			
STRIPED MARLIN	24,414	24,414	\$28,140
BLUE MARLIN	8,704	8,704	\$7,680
BROADBILL	695	695	\$1,238
MAHIMAH	8,852	8,784	\$18,527
ONO	2,595	2,595	\$4,602
SHARK	270	270	\$102
SHORTBILL SPEARFISH	320	320	\$256
GEAR = DEEP-SEA HANDLINE			
STRIPED MARLIN	4,305	4,206	\$6,018
BLUE MARLIN	26,389	24,074	\$13,868
BROADBILL	30,807	30,480	\$41,116
SAILFISH	447	407	\$416
MAHIMAH	40,872	39,501	\$87,169
ONO	40,343	39,202	\$76,334
SHARK	5,257	241	\$90
SHORTBILL SPEARFISH	642	515	\$468
BLACK MARLIN	527	249	\$447
GEAR = INSHORE HANDLINE			
MAHIMAH	105	94	\$240
ONO	48	44	\$37
SHARK	1,333	13	\$6
SHORTBILL SPEARFISH	6	6	\$8
GEAR = TROLLING LINE			
STRIPED MARLIN	38,247	30,090	\$36,015
BLUE MARLIN	405,787	349,258	\$168,863
BROADBILL	1,032	1,032	\$1,219
SAILFISH	510	272	\$182
MAHIMAH	180,281	154,688	\$333,762
ONO	223,035	196,497	\$370,600
SHARK	4,751	200	\$50
HAMMERHEAD SHARK	219	120	\$35
SHORTBILL SPEARFISH	11,029	8,281	\$7,421
BLACK MARLIN	5,333	4,895	\$3,344

Table 7.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
	GEAR = OTHER		
BLUE MARLIN	650	650	\$195
BROADBILL	490	490	\$515
MAHIMAH	8,550	8,550	\$16,321
ONO	415	385	\$589
SHARK	621	21	\$12
HAMMERHEAD SHARK	225	225	\$96
SHORTBILL SPEARFISH	1	1	\$1
BLACK MARLIN	10	4	\$2

I TABLE 7.-- HDAR 1981 DATA BY GEAR AND SPECIES.

SPECIES	LB CAUGHT	LBS SOLD	REVENUE
GEAR = FLAGLINE			
STRIPED MARLIN	11,659	11,659	\$14,234
BLUE MARLIN	2,055	2,055	\$1,893
BROADBILL	26	26	\$14
SAILFISH	103	103	\$85
MAHIMAH I	3,103	3,058	\$7,335
ONO	497	497	\$1,231
SHORTBILL SPEARFISH	67	67	\$50
GEAR = DEEP-SEA HANDLINE			
STRIPED MARLIN	673	670	\$734
BLUE MARLIN	6,468	5,772	\$5,692
BROADBILL	1,635	1,581	\$2,755
SAILFISH	21	21	\$15
MAHIMAH I	15,252	14,821	\$36,563
ONO	13,700	13,360	\$30,219
SHARK	3,891	650	\$306
SHORTBILL SPEARFISH	602	551	\$426
GEAR = INSHORE HANDLINE			
ONO	22	--	--
SHARK	793	--	--
SHORTBILL SPEARFISH	54	54	\$24
GEAR = TROLLING LINE			
STRIPED MARLIN	18,778	14,543	\$17,785
BLUE MARLIN	105,361	88,953	\$58,643
SAILFISH	260	180	\$183
MAHIMAH I	71,338	60,999	\$145,463
ONO	52,902	48,006	\$112,579
SHARK	550	--	--
HAMMERHEAD SHARK	200	--	--
SHORTBILL SPEARFISH	5,277	3,601	\$4,084
BLACK MARLIN	3,857	3,491	\$2,075
GEAR = OTHER			
MAHIMAH I	3,160	3,160	\$5,218
ONO	13	13	\$19
SHARK	1	1	\$1

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TABLE 8.--HDAR 1976 DATA -- BY GEAR.

REGION	LB CAUGHT	LBS SOLD	REVENUE
GEAR = FLAGLINE			
0 TO 2 MILES	708	708	\$820.13
2 TO 20 MILES	109,869	109,869	\$120,038.25
BEYOND 20 MILES	12,904	12,904	\$14,742.32
GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	5,061	4,558	\$3,542.59
2 TO 20 MILES	80,699	74,748	\$66,338.94
NORTHWESTERN H.I.	8,267	8,267	\$6,174.52
BEYOND 20 MILES	2,781	2,751	\$3,080.78
GEAR = INSHORE HANDLINE			
0 TO 2 MILES	915	842	\$871.27
2 TO 20 MILES	277	277	\$301.31
GEAR = TROLLING LINE			
0 TO 2 MILES	34,064	25,612	\$23,554.90
2 TO 20 MILES	463,892	303,530	\$225,284.05
BEYOND 20 MILES	8,734	7,707	\$6,953.21
OTHER	228	193	\$244.54
GEAR = OTHER			
0 TO 2 MILES	1,200	303	\$377.20
2 TO 20 MILES	6,244	6,192	\$10,462.15
BEYOND 20 MILES	1,132	1,132	\$1,538.02
HDAR 1977 DATA BY GEAR			
GEAR = FLAGLINE			
0 TO 2 MILES	55	55	\$83.25
2 TO 20 MILES	154,789	154,789	\$202,147.78
BEYOND 20 MILES	11,358	11,358	\$14,211.75
GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	6,462	5,627	\$5,767.76
2 TO 20 MILES	62,535	57,499	\$57,092.45
NORTHWESTERN H.I.	612	612	\$817.28
BEYOND 20 MILES	2,458	2,458	\$3,000.07

Table 8.--Continued.

REGION	LB CAUGHT	LB SOLD	REVENUE
GEAR = INSHORE HANDLINE			
0 TO 2 MILES	900	435	\$565.82
2 TO 20 MILES	1,133	1,078	\$1,149.10
BEYOND 20 MILES	230	0	\$0.00
GEAR = TROLLING LINE			
0 TO 2 MILES	40,426	32,332	\$35,231.55
2 TO 20 MILES	597,374	446,267	\$369,628.41
NORTHWESTERN H.I.	1,075	1,075	\$888.40
BEYOND 20 MILES	8,270	6,579	\$5,327.41
OTHER	304	254	\$270.41
GEAR = OTHER			
0 TO 2 MILES	1,139	559	\$727.40
2 TO 20 MILES	6,452	6,207	\$10,994.10
BEYOND 20 MILES	2,773	2,773	\$4,548.82
HDAR 1978 DATA BY GEAR			
GEAR = FLAGLINE			
0 TO 2 MILES	1,415	1,415	\$2,243.43
2 TO 20 MILES	170,487	160,067	\$212,570.06
BEYOND 20 MILES	36,828	36,828	\$47,161.76
GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	1,088	835	\$1,071.05
2 TO 20 MILES	61,586	57,463	\$67,857.24
NORTHWESTERN H.I.	2,114	2,114	\$5,030.36
BEYOND 20 MILES	2,621	2,571	\$2,035.98
GEAR = INSHORE HANDLINE			
0 TO 2 MILES	4,621	4,138	\$4,590.87
2 TO 20 MILES	87	53	\$81.25
GEAR = TROLLING LINE			
0 TO 2 MILES	26,734	18,506	\$23,069.07
2 TO 20 MILES	751,680	586,105	\$492,117.31
BEYOND 20 MILES	16,693	14,951	\$8,051.27
OTHER	2,085	2,085	\$2,527.60

Table 8.--Continued.

REGION	LB CAUGHT	LB SOLD	REVENUE
GEAR = OTHER			
0 TO 2 MILES	1,817	47	\$8.45
2 TO 20 MILES	8,819	8,787	\$16,654.80
BEYOND 20 MILES	514	514	\$1,201.38
OTHER	14	14	\$37.67
HDAR 1979 DATA BY GEAR			
GEAR = FLAGLINE			
0 TO 2 MILES	539	539	\$979.00
2 TO 20 MILES	109,179	109,179	\$157,398.00
BEYOND 20 MILES	8,882	8,882	\$14,053.00
OTHER	1,412	1,388	\$2,155.00
GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	8,514	8,009	\$11,261.00
2 TO 20 MILES	67,628	65,005	\$94,727.00
NORTHWESTERN H.I.	237	237	\$309.00
BEYOND 20 MILES	5,784	5,605	\$8,758.00
OTHER	5	--	--
GEAR = INSHORE HANDLINE			
0 TO 2 MILES	427	312	\$488.00
2 TO 20 MILES	14	--	--
GEAR = TROLLING LINE			
0 TO 2 MILES	54,365	44,911	\$60,285.00
2 TO 20 MILES	690,987	551,515	\$581,217.00
NORTHWESTERN H.I.	7,124	7,124	\$16,031.00
BEYOND 20 MILES	17,269	14,202	\$7,897.00
OTHER	1,747	1,567	\$3,691.00
GEAR = OTHER			
0 TO 2 MILES	3,761	834	\$985.00
2 TO 20 MILES	7,668	7,343	\$12,710.00
BEYOND 20 MILES	4,292	4,262	\$5,501.00
OTHER	37	37	\$34.00

Table 8.--Continued.

HDAR 1980 DATA BY GEAR			
REGION	LB CAUGHT	LBSOLD	REVENUE
GEAR = FLAGLINE			
2 TO 20 MILES	37,148	37,148	\$49,218.00
BEYOND 20 MILES	8,702	8,634	\$11,327.00
GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	20,812	15,190	\$23,767.00
2 TO 20 MILES	121,739	116,812	\$189,933.00
NORTHWESTERN H.I.	18	18	\$10.00
BEYOND 20 MILES	6,956	6,791	\$12,110.00
OTHER	64	64	\$106.00
GEAR = INSHORE HANDLINE			
0 TO 2 MILES	1,479	144	\$256.00
2 TO 20 MILES	13	13	\$35.00
GEAR = TROLLING LINE			
0 TO 2 MILES	70,417	59,779	\$104,502.00
2 TO 20 MILES	782,555	672,098	\$801,405.00
NORTHWESTERN H.I.	4,238	4,238	\$8,149.00
BEYOND 20 MILES	12,729	8,946	\$7,082.00
OTHER	285	272	\$353.00
GEAR = OTHER			
0 TO 2 MILES	1,030	424	\$372.00
2 TO 20 MILES	6,455	6,425	\$11,685.00
BEYOND 20 MILES	3,457	3,457	\$5,615.00
OTHER	20	20	\$59.00
HDAR 1981 DATA BY GEAR			
GEAR = FLAGLINE			
2 TO 20 MILES	8,067	8,067	\$13,125.00
BEYOND 20 MILES	8,783	8,738	\$10,933.00
OTHER	660	660	\$784.00

Table 8.--Continued.

REGION	LBCAUGHT	LBSOLD	REVENUE
GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	3,301	2,775	\$5,972.00
2 TO 20 MILES	37,799	33,609	\$69,693.00
NORTHWESTERN H.I.	115	115	\$106.00
BEYOND 20 MILES	1,018	918	\$921.00
OTHER	9	9	\$18.00
GEAR = INSHORE HANDLINE			
0 TO 2 MILES	869	54	\$24.00
GEAR = TROLLING LINE			
0 TO 2 MILES	15,919	14,009	\$31,846.00
2 TO 20 MILES	236,656	199,899	\$297,042.00
NORTHWESTERN H.I.	2,873	2,873	\$5,600.00
BEYOND 20 MILES	2,849	2,766	\$5,691.00
OTHER	226	226	\$633.00
GEAR = OTHER			
0 TO 2 MILES	47	47	\$189.00
2 TO 20 MILES	2,810	2,810	\$4,065.00
BEYOND 20 MILES	317	317	\$984.00

I TABLE 9.--HDAR 1976 DATA BY GEAR, REGION, AND SPECIES.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
GEAR = FLAGLINE REGION = 0 TO 2 MILES			
STRIPED MARLIN	708	708	\$820
GEAR = FLAGLINE REGION = 2 TO 20 MILES			
STRIPED MARLIN	67,317	67,317	\$71,689
BLUE MARLIN	14,553	14,553	\$10,739
BROADBILL	429	429	\$174
SAILFISH	529	529	\$253
MAHIMAH	15,087	15,087	\$27,553
ONO	5,843	5,843	\$5,120
SHORTBILL SPEARFISH	5,692	5,692	\$4,067
BLACK MARLIN	419	419	\$443
GEAR = FLAGLINE REGION = BEYOND 20 MILES			
STRIPED MARLIN	6,239	6,239	\$8,609
BLUE MARLIN	2,198	2,198	\$1,351
SAILFISH	55	55	\$17
MAHIMAH	1,374	1,374	\$2,450
ONO	1,693	1,693	\$1,290
SHORTBILL SPEARFISH	1,345	1,345	\$1,026
GEAR = DEEP-SEA HANDLINE REGION = 0 TO 2 MILES			
STRIPED MARLIN	1,002	1,002	\$181
BLUE MARLIN	490	189	\$38
BROADBILL	103	103	\$52
SAILFISH	46	46	\$14
MAHIMAH	992	820	\$1,112
ONO	2,418	2,398	\$2,146
SHARK	10	0	\$0
GEAR = DEEP-SEA HANDLINE REGION = 2 TO 20 MILES			
STRIPED MARLIN	10,895	9,942	\$3,841
BLUE MARLIN	10,748	10,564	\$3,708
BROADBILL	2,356	2,074	\$1,337
SAILFISH	235	159	\$41
MAHIMAH	22,526	21,703	\$32,091
ONO	32,202	28,908	\$24,969
SHARK	339	0	\$0
SHORTBILL SPEARFISH	395	395	\$189
BLACK MARLIN	1,003	1,003	\$163

Table 9.--Continued.

SPECIES	LB CAUGHT	LBS SOLD	REVENUE
GEAR = DEEP-SEA HANDLINE REGION = NORTHWESTERN H.I.			
MAHIMAHI	67	67	\$93
ONO	8,200	8,200	\$6,082
GEAR = DEEP-SEA HANDLINE REGION = BEYOND 20 MILES			
STRIPED MARLIN	442	442	\$398
BROADBILL	90	90	\$45
SAILFISH	176	176	\$95
MAHIMAHI	1,215	1,215	\$1,741
ONO	204	174	\$138
SHORTBILL SPEARFISH	654	654	\$664
GEAR = INSHORE HANDLINE REGION = 0 TO 2 MILES			
STRIPED MARLIN	79	79	\$98
MAHIMAHI	262	216	\$316
ONO	547	547	\$458
HAMMERHEAD SHARK	27	0	\$0
GEAR = INSHORE HANDLINE REGION = 2 TO 20 MILES			
MAHIMAHI	107	107	\$137
ONO	170	170	\$164
GEAR = TROLLING LINE REGION = 0 TO 2 MILES			
STRIPED MARLIN	5,145	3,115	\$1,017
BLUE MARLIN	4,543	3,835	\$1,267
SAILFISH	98	98	\$23
MAHIMAHI	4,644	3,178	\$4,595
ONO	19,220	15,321	\$16,565
SHORTBILL SPEARFISH	414	65	\$89
GEAR = TROLLING LINE REGION = 2 TO 20 MILES			
STRIPED MARLIN	115,602	68,775	\$26,081
BLUE MARLIN	154,514	97,079	\$33,522
BROADBILL	543	543	\$451
SAILFISH	1,204	613	\$251
MAHIMAHI	82,987	58,340	\$92,483
ONO	98,587	71,550	\$69,846
SHARK	260	0	\$0
SHORTBILL SPEARFISH	5,141	2,985	\$1,319
BLACK MARLIN	5,054	3,645	\$1,330

Table 9.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
GEAR = TROLLING LINE REGION = BEYOND 20 MILES			
STRIPED MARLIN	1,485	1,485	\$1,150
BLUE MARLIN	4,174	3,670	\$1,681
MAHIMAHI	2,332	1,818	\$3,579
ONO	265	260	\$228
SHORTBILL SPEARFISH	81	77	\$19
BLACK MARLIN	397	397	\$297
GEAR = TROLLING LINE REGION = OTHER			
STRIPED MARLIN	70	50	\$75
MAHIMAHI	102	87	\$131
ONO	56	56	\$39
GEAR = OTHER REGION = 0 TO 2 MILES			
MAHIMAHI	305	303	\$377
SHARK	760	0	\$0
HAMMERHEAD SHARK	135	0	\$0
GEAR = OTHER REGION = 2 TO 20 MILES			
MAHIMAHI	5,958	5,906	\$10,205
ONO	277	277	\$250
SHARK	9	9	\$7
GEAR = OTHER REGION = BEYOND 20 MILES			
MAHIMAHI	1,132	1,132	\$1,538

I TABLE 9.--HDAR 1977 DATA BY GEAR, REGION, AND SPECIES.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
GEAR = FLAGLINE REGION = 0 TO 2 MILES			
MAHIMAHI	55	55	\$83
GEAR = FLAGLINE REGION = 2 TO 20 MILES			
STRIPED MARLIN	64,772	64,772	\$79,657
BLUE MARLIN	22,523	22,523	\$17,834
BROADBILL	35,362	35,362	\$61,388
SAILFISH	620	620	\$626
MAHIMAHI	13,805	13,805	\$27,620
ONO	11,316	11,316	\$10,204
SHORTBILL SPEARFISH	6,133	6,133	\$4,419
BLACK MARLIN	258	258	\$401
GEAR = FLAGLINE REGION = BEYOND 20 MILES			
STRIPED MARLIN	5,161	5,161	\$6,603
BLUE MARLIN	2,103	2,103	\$1,636
BROADBILL	1,603	1,603	\$2,830
SAILFISH	114	114	\$69
MAHIMAHI	1,007	1,007	\$1,761
ONO	868	868	\$963
SHORTBILL SPEARFISH	297	297	\$175
BLACK MARLIN	205	205	\$174
GEAR = DEEP-SEA HANDLINE REGION = 0 TO 2 MILES			
BLUE MARLIN	895	534	\$333
MAHIMAHI	1,817	1,757	\$2,607
ONO	3,202	3,202	\$2,810
SHARK	548	134	\$18
GEAR = DEEP-SEA HANDLINE REGION = 2 TO 20 MILES			
STRIPED MARLIN	1,217	1,174	\$1,095
BLUE MARLIN	15,858	13,196	\$5,776
BROADBILL	3,756	3,756	\$3,191
SAILFISH	107	39	\$23
MAHIMAHI	15,462	14,563	\$22,993
ONO	24,237	23,402	\$23,408
SHARK	695	416	\$112
SHORTBILL SPEARFISH	473	396	\$163
BLACK MARLIN	730	557	\$332
GEAR = DEEP-SEA HANDLINE REGION = NORTHWESTERN H.I.			
ONO	612	612	\$817

Table 9.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
GEAR = DEEP-SEA HANDLINE REGION = BEYOND 20 MILES			
STRIPED MARLIN	110	110	\$105
BROADBILL	224	224	\$198
SAILFISH	26	26	\$17
MAHIMAHI	971	971	\$1,598
ONO	1,127	1,127	\$1,082
GEAR = INSHORE HANDLINE REGION = 0 TO 2 MILES			
MAHIMAHI	226	211	\$369
ONO	224	224	\$196
SHARK	450	0	\$0
GEAR = INSHORE HANDLINE REGION = 2 TO 20 MILES			
STRIPED MARLIN	100	100	\$100
MAHIMAHI	228	228	\$299
ONO	805	750	\$750
GEAR = INSHORE HANDLINE REGION = BEYOND 20 MILES			
SHARK	230	0	\$0
GEAR = TROLLING LINE REGION = 0 TO 2 MILES			
STRIPED MARLIN	622	566	\$290
BLUE MARLIN	6,810	3,641	\$1,252
SAILFISH	135	135	\$119
MAHIMAHI	5,955	4,807	\$6,714
ONO	26,730	23,109	\$26,810
SHARK	100	0	\$0
SHORTBILL SPEARFISH	74	74	\$47
GEAR = TROLLING LINE REGION = 2 TO 20 MILES			
SWORDFISH	138	138	\$62
STRIPED MARLIN	18,923	10,922	\$9,086
BLUE MARLIN	314,008	228,526	\$81,502
BROADBILL	290	290	\$323
SAILFISH	376	223	\$133
MAHIMAHI	100,538	77,578	\$141,838
ONO	151,358	122,348	\$134,072
SHARK	461	161	\$32
SHORTBILL SPEARFISH	5,676	2,886	\$1,449
BLACK MARLIN	5,606	3,195	\$1,132

Table 9.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
GEAR = TROLLING LINE REGION = NORTHWESTERN H.I.			
MAHIMAHI	20	20	\$30
ONO	1,055	1,055	\$858
GEAR = TROLLING LINE REGION = BEYOND 20 MILES			
STRIPED MARLIN	381	331	\$270
BLUE MARLIN	4,023	2,962	\$1,183
SAILFISH	7	0	\$0
MAHIMAHI	1,482	1,311	\$2,299
ONO	1,070	668	\$1,011
SHORTBILL SPEARFISH	29	29	\$49
BLACK MARLIN	1,278	1,278	\$516
GEAR = TROLLING LINE REGION = OTHER			
STRIPED MARLIN	50	0	\$0
ONO	254	254	\$270
GEAR = OTHER REGION = 0 TO 2 MILES			
MAHIMAHI	293	293	\$480
ONO	182	182	\$182
SHARK	543	3	\$0
HAMMERHEAD SHARK	40	0	\$0
SHORTBILL SPEARFISH	81	81	\$66
GEAR = OTHER REGION = 2 TO 20 MILES			
SAILFISH	22	22	\$13
MAHIMAHI	5,696	5,671	\$10,564
ONO	380	360	\$372
SHARK	354	154	\$45
GEAR = OTHER REGION = BEYOND 20 MILES			
MAHIMAHI	2,765	2,765	\$4,543
ONO	8	8	\$6

TABLE 9.--HDAR 1978 DATA BY GEAR, REGION, AND SPECIES.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
GEAR = FLAGLINE REGION = 0 TO 2 MILES			
MAHIMAHI	881	881	\$1,469
ONO	534	534	\$775
GEAR = FLAGLINE REGION = 2 TO 20 MILES			
STRIPED MARLIN	87,889	87,889	\$124,052
BLUE MARLIN	34,622	34,622	\$32,643
BROADBILL	11,952	11,282	\$17,181
SAILFISH	49	49	\$37
MAHIMAHI	7,449	7,449	\$17,480
ONO	7,722	7,722	\$9,701
SHARK	11,085	1,335	\$453
SHORTBILL SPEARFISH	9,719	9,719	\$11,023
GEAR = FLAGLINE REGION = BEYOND 20 MILES			
STRIPED MARLIN	17,382	17,382	\$21,314
BLUE MARLIN	5,458	5,458	\$4,536
BROADBILL	8,530	8,530	\$12,683
MAHIMAHI	2,092	2,092	\$4,336
ONO	1,917	1,917	\$2,677
SHORTBILL SPEARFISH	1,449	1,449	\$1,616
GEAR = DEEP-SEA HANDLINE REGION = 0 TO 2 MILES			
SAILFISH	70	70	\$70
MAHIMAHI	307	307	\$486
ONO	411	386	\$490
SHARK	300	72	\$25
GEAR = DEEP-SEA HANDLINE REGION = 2 TO 20 MILES			
STRIPED MARLIN	2,613	2,287	\$2,280
BLUE MARLIN	11,156	10,809	\$4,945
BROADBILL	8,916	8,916	\$10,235
SAILFISH	43	43	\$15
MAHIMAHI	12,654	12,111	\$22,111
ONO	21,887	21,438	\$27,124
SHARK	3,740	1,282	\$472
SHORTBILL SPEARFISH	577	577	\$676
GEAR = DEEP-SEA HANDLINE REGION = NORTHWESTERN H.I.			
MAHIMAHI	118	118	\$192
ONO	1,996	1,996	\$4,839

Table 9.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
GEAR = DEEP-SEA HANDLINE REGION = BEYOND 20 MILES			
STRIPED MARLIN	585	545	\$409
BLUE MARLIN	988	988	\$280
BROADBILL	140	140	\$105
MAHIMAH	512	512	\$843
ONO	314	304	\$354
SHARK	82	82	\$44
GEAR = INSHORE HANDLINE REGION = 0 TO 2 MILES			
STRIPED MARLIN	136	136	\$54
BLUE MARLIN	1,114	1,114	\$465
BROADBILL	47	47	\$47
MAHIMAH	850	787	\$1,424
ONO	1,943	1,888	\$2,529
SHARK	531	166	\$72
GEAR = INSHORE HANDLINE REGION = 2 TO 20 MILES			
MAHIMAH	19	19	\$29
ONO	68	34	\$53
GEAR = TROLLING LINE REGION = 0 TO 2 MILES			
STRIPED MARLIN	497	337	\$279
BLUE MARLIN	6,863	3,822	\$1,716
MAHIMAH	3,898	2,984	\$4,908
ONO	13,951	11,303	\$16,131
SHARK	1,525	60	\$35
GEAR = TROLLING LINE REGION = 2 TO 20 MILES			
STRIPED MARLIN	36,752	26,545	\$25,476
BLUE MARLIN	464,326	360,320	\$157,749
BROADBILL	558	558	\$736
SAILFISH	535	210	\$101
MAHIMAH	91,774	72,874	\$144,685
ONO	140,566	116,466	\$156,433
SHARK	3,164	964	\$393
SHORTBILL SPEARFISH	12,637	7,744	\$6,109
BLACK MARLIN	1,368	424	\$434

Table 9.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
GEAR = TROLLING LINE REGION = BEYOND 20 MILES			
STRIPED MARLIN	1,167	1,045	\$789
BLUE MARLIN	12,791	11,656	\$3,761
MAHIMAHI	772	548	\$1,274
ONO	1,626	1,395	\$1,945
SHORTBILL SPEARFISH	337	307	\$282
GEAR = TROLLING LINE REGION = OTHER			
MAHIMAHI	172	172	\$371
ONO	1,913	1,913	\$2,157
GEAR = OTHER REGION = 0 TO 2 MILES			
MAHIMAHI	4	4	\$6
ONO	43	0	\$0
SHARK	243	43	\$2
HAMMERHEAD SHARK	1,527	--	--
GEAR = OTHER REGION = 2 TO 20 MILES			
MAHIMAHI	8,732	8,732	\$16,600
ONO	87	55	\$55
GEAR = OTHER REGION = BEYOND 20 MILES			
MAHIMAHI	514	514	\$1,201
GEAR = OTHER REGION = OTHER			
MAHIMAHI	14	14	\$38

I TABLE 9.--HDAR 1979 DATA BY GEAR, REGION, AND SPECIES.

SPECIES	LB CAUGHT	LBS SOLD	REVENUE
GEAR = FLAGLINE REGION = 0 TO 2 MILES			
MAHIMAH I	510	510	\$920
ONO	29	29	\$59
GEAR = FLAGLINE REGION = 2 TO 20 MILES			
STRIPED MARLIN	66,510	66,510	\$94,880
BLUE MARLIN	13,747	13,747	\$14,536
BROADBILL	14,278	14,278	\$23,566
SAILFISH	677	677	\$597
MAHIMAH I	6,508	6,508	\$13,655
ONO	2,741	2,741	\$5,247
SHARK	871	871	\$397
SHORTBILL SPEARFISH	3,747	3,747	\$4,422
BLACK MARLIN	100	100	\$98
GEAR = FLAGLINE REGION = BEYOND 20 MILES			
STRIPED MARLIN	4,954	4,954	\$8,903
BLUE MARLIN	1,481	1,481	\$1,507
BROADBILL	220	220	\$330
SAILFISH	73	73	\$42
MAHIMAH I	553	553	\$1,054
ONO	445	445	\$1,206
SHARK	534	534	\$188
SHORTBILL SPEARFISH	622	622	\$823
GEAR = FLAGLINE REGION = OTHER			
STRIPED MARLIN	397	397	\$288
BROADBILL	300	300	\$498
MAHIMAH I	274	250	\$620
ONO	297	297	\$565
BLACK MARLIN	144	144	\$184
GEAR = DEEP-SEA HANDLINE REGION = 0 TO 2 MILES			
STRIPED MARLIN	286	216	\$115
BLUE MARLIN	705	705	\$436
BROADBILL	827	812	\$1,152
MAHIMAH I	2,314	2,061	\$3,261
ONO	4,135	3,968	\$6,140
SHORTBILL SPEARFISH	45	45	\$56
BLACK MARLIN	202	202	\$101

Table 9.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
GEAR = DEEP SEA HANDLINE REGION = 2 TO 20 MILES			
SWORDFISH	2	--	--
STRIPED MARLIN	4,474	4,364	\$5,493
BLUE MARLIN	12,508	12,211	\$8,980
BROADBILL	12,201	12,201	\$16,812
SAILFISH	99	99	\$82
MAHIMAHI	19,285	18,307	\$34,539
ONO	16,826	16,148	\$27,170
SHARK	190	--	--
SHORTBILL SPEARFISH	410	390	\$329
BLACK MARLIN	1,633	1,285	\$1,322
GEAR = DEEP-SEA HANDLINE REGION = NORTHWESTERN H.I.			
BROADBILL	141	141	\$176
ONO	96	96	\$133
GEAR = DEEP-SEA HANDLINE REGION = BEYOND 20 MILES			
STRIPED MARLIN	644	644	\$781
BLUE MARLIN	1,569	1,464	\$1,267
BROADBILL	621	621	\$812
SAILFISH	77	77	\$86
MAHIMAHI	2,040	2,040	\$3,891
ONO	833	759	\$1,921
GEAR = DEEP-SEA HANDLINE REGION = OTHER			
ONO	5	--	--
GEAR = INSHORE HANDLINE REGION = 0 TO 2 MILES			
MAHIMAHI	87	80	\$127
ONO	282	232	\$361
SHARK	58	--	--
GEAR = INSHORE HANDLINE REGION = 2 TO 20 MILES			
MAHIMAHI	14	--	--

Table 9.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
GEAR = TROLLING LINE REGION = 0 TO 2 MILES			
STRIPED MARLIN	989	837	\$992
BLUE MARLIN	18,386	14,922	\$6,171
SAILFISH	152	77	\$56
MAHIMAHI	6,399	4,960	\$9,263
ONO	27,982	23,658	\$43,499
SHARK	66	66	\$6
SHORTBILL SPEARFISH	391	391	\$298
GEAR = TROLLING LINE REGION = 2 TO 20 MILES			
STRIPED MARLIN	32,110	24,362	\$25,454
BLUE MARLIN	374,958	294,078	\$138,877
BROADBILL	350	121	\$96
SAILFISH	1,203	604	\$351
MAHIMAHI	124,447	104,039	\$206,138
ONO	136,589	114,537	\$199,021
SHARK	1,549	238	\$37
HAMMERHEAD SHARK	150	--	--
SHORTBILL SPEARFISH	11,013	7,425	\$8,383
BLACK MARLIN	8,618	6,111	\$2,860
GEAR = TROLLING LINE REGION = NORTHWESTERN H.I.			
MAHIMAHI	30	30	\$30
ONO	7,094	7,094	\$16,001
GEAR = TROLLING LINE REGION = BEYOND 20 MILES			
STRIPED MARLIN	875	700	\$445
BLUE MARLIN	13,042	11,255	\$4,082
MAHIMAHI	1,395	997	\$1,834
ONO	1,285	822	\$1,256
SHORTBILL SPEARFISH	229	110	\$129
BLACK MARLIN	443	318	\$151
GEAR = TROLLING LINE REGION = OTHER			
BLUE MARLIN	180	--	--
MAHIMAHI	311	311	\$647
ONO	1,218	1,218	\$3,025
SHORTBILL SPEARFISH	38	38	\$19

Table 9.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
GEAR = OTHER REGION = 0 TO 2 MILES			
MAHIMAHI	98	98	\$203
ONO	28	28	\$65
SHARK	1,026	29	\$48
HAMMERHEAD SHARK	1,880	--	--
SHORTBILL SPEARFISH	729	679	\$669
GEAR = OTHER REGION = 2 TO 20 MILES			
STRIPED MARLIN	330	75	\$172
BLUE MARLIN	659	659	\$98
MAHIMAHI	6,492	6,447	\$12,328
ONO	52	27	\$71
SHARK	135	135	\$41
GEAR = OTHER REGION = BEYOND 20 MILES			
STRIPED MARLIN	232	232	\$153
BLUE MARLIN	234	234	\$70
MAHIMAHI	3,754	3,754	\$5,205
ONO	42	42	\$73
SHORTBILL SPEARFISH	30	--	--
GEAR = OTHER REGION = OTHER			
MAHIMAHI	37	37	\$34

I TABLE 9.--HDAR 1980 DATA BY GEAR, REGION, AND SPECIES.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
GEAR = FLAGLINE REGION = 2 TO 20 MILES			
STRIPED MARLIN	19,875	19,875	\$22,815
BLUE MARLIN	6,870	6,870	\$5,920
BROADBILL	489	489	\$1,028
MAHIMAH	7,562	7,562	\$15,981
ONO	2,014	2,014	\$3,295
SHARK	101	101	\$35
SHORTBILL SPEARFISH	237	237	\$144
GEAR = FLAGLINE REGION = BEYOND 20 MILES			
STRIPED MARLIN	4,539	4,539	\$5,325
BLUE MARLIN	1,834	1,834	\$1,760
BROADBILL	206	206	\$210
MAHIMAH	1,290	1,222	\$2,546
ONO	581	581	\$1,307
SHARK	169	169	\$67
SHORTBILL SPEARFISH	83	83	\$112
GEAR = DEEP-SEA HANDLINE REGION = 0 TO 2 MILES			
STRIPED MARLIN	449	449	\$337
BLUE MARLIN	4,634	3,910	\$1,755
BROADBILL	445	445	\$632
MAHIMAH	5,475	5,268	\$11,670
ONO	5,035	5,010	\$9,239
SHARK	4,666	--	--
SHORTBILL SPEARFISH	108	108	\$134
GEAR = DEEP-SEA HANDLINE REGION = 2 TO 20 MILES			
STRIPED MARLIN	2,466	2,367	\$3,085
BLUE MARLIN	20,565	18,974	\$10,971
BROADBILL	29,510	29,183	\$39,393
SAILFISH	273	233	\$126
MAHIMAH	33,537	32,508	\$71,323
ONO	33,780	32,694	\$64,184
SHARK	591	241	\$90
SHORTBILL SPEARFISH	490	363	\$314
BLACK MARLIN	527	249	\$447
GEAR = DEEP-SEA HANDLINE REGION = NORTHWESTERN H.I.			
SHORTBILL SPEARFISH	18	18	\$10

Table 9.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
GEAR = DEEP-SEA HANDLINE REGION = BEYOND 20 MILES			
STRIPED MARLIN	1,390	1,390	\$2,596
BLUE MARLIN	1,190	1,190	\$1,142
BROADBILL	852	852	\$1,091
SAILFISH	174	174	\$290
MAHIMAHI	1,854	1,719	\$4,167
ONO	1,470	1,440	\$2,814
SHORTBILL SPEARFISH	26	26	\$10
GEAR = DEEP-SEA HANDLINE REGION = OTHER			
MAHIMAHI	6	6	\$9
ONO	58	58	\$97
GEAR = INSHORE HANDLINE REGION = 0 TO 2 MILES			
MAHIMAHI	92	81	\$205
ONO	48	44	\$37
SHARK	1,333	13	\$6
SHORTBILL SPEARFISH	6	6	\$8
GEAR = INSHORE HANDLINE REGION = 2 TO 20 MILES			
MAHIMAHI	13	13	\$35
GEAR = TROLLING LINE REGION = 0 TO 2 MILES			
STRIPED MARLIN	1,455	1,306	\$1,742
BLUE MARLIN	14,378	11,638	\$6,015
BROADBILL	158	158	\$237
SAILFISH	64	--	--
MAHIMAHI	13,451	11,594	\$27,424
ONO	39,327	34,314	\$68,568
SHARK	763	113	\$39
HAMMERHEAD SHARK	95	--	--
SHORTBILL SPEARFISH	271	201	\$186
BLACK MARLIN	455	455	\$291

Table 9.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
GEAR = TROLLING LINE REGION = 2 TO 20 MILES			
STRIPED MARLIN	36,229	28,261	\$33,679
BLUE MARLIN	382,176	330,882	\$159,730
BROADBILL	874	874	\$982
SAILFISH	446	272	\$182
MAHIMAH I	164,732	141,667	\$303,092
ONO	178,897	157,802	\$293,694
SHARK	3,988	87	\$11
HAMMERHEAD SHARK	124	120	\$35
SHORTBILL SPEARFISH	10,431	7,913	\$7,057
BLACK MARLIN	4,658	4,220	\$2,943
GEAR = TROLLING LINE REGION = NORTHWESTERN H.I.			
BLUE MARLIN	173	173	\$96
MAHIMAH I	352	352	\$808
ONO	3,713	3,713	\$7,245
GEAR = TROLLING LINE REGION = BEYOND 20 MILES			
STRIPED MARLIN	486	446	\$496
BLUE MARLIN	9,060	6,565	\$3,022
MAHIMAH I	1,676	1,018	\$2,349
ONO	960	530	\$927
SHORTBILL SPEARFISH	327	167	\$178
BLACK MARLIN	220	220	\$110
GEAR = TROLLING LINE REGION = OTHER			
STRIPED MARLIN	77	77	\$98
MAHIMAH I	70	57	\$89
ONO	138	138	\$166
GEAR = OTHER REGION = 0 TO 2 MILES			
MAHIMAH I	66	66	\$100
ONO	107	107	\$161
SHARK	621	21	\$12
HAMMERHEAD SHARK	225	225	\$96
SHORTBILL SPEARFISH	1	1	\$1
BLACK MARLIN	10	4	\$2

Table 9.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
	GEAR = OTHER	REGION = 2 TO 20 MILES	
BLUE MARLIN	650	650	\$195
BROADBILL	490	490	\$515
MAHIMAHI	5,007	5,007	\$10,547
ONO	308	278	\$428
	GEAR = OTHER	REGION = BEYOND. 20 MILES	
MAHIMAHI	3,457	3,457	\$5,615
	GEAR = OTHER	REGION = OTHER	
MAHIMAHI	20	20	\$59

I TABLE 9.--HDAR 1981 DATA BY GEAR, REGION, AND SPECIES.

SPECIES	LB CAUGHT	LBS SOLD	REVENUE
GEAR = FLAGLINE REGION = 2 TO 20 MILES			
STRIPED MARLIN	4,773	4,773	\$5,838
BLUE MARLIN	384	384	\$393
MAHIMAH I	2,514	2,514	\$6,027
ONO	329	329	\$817
SHORTBILL SPEARFISH	67	67	\$50
GEAR = FLAGLINE REGION = BEYOND 20 MILES			
STRIPED MARLIN	6,504	6,504	\$7,862
BLUE MARLIN	1,393	1,393	\$1,250
BROADBILL	26	26	\$14
SAILFISH	103	103	\$85
MAHIMAH I	589	544	\$1,308
ONO	168	168	\$414
GEAR = FLAGLINE REGION = OTHER			
STRIPED MARLIN	382	382	\$534
BLUE MARLIN	278	278	\$250
GEAR = DEEP-SEA HANDLINE REGION = 0 TO 2 MILES			
STRIPED MARLIN	47	47	\$47
BLUE MARLIN	546	430	\$561
BROADBILL	14	14	\$10
SAILFISH	21	21	\$15
MAHIMAH I	1,490	1,420	\$3,621
ONO	902	843	\$1,718
SHARK	281	--	--
GEAR = DEEP-SEA HANDLINE REGION = 2 TO 20 MILES			
STRIPED MARLIN	588	585	\$665
BLUE MARLIN	5,432	4,852	\$5,009
BROADBILL	1,621	1,567	\$2,745
MAHIMAH I	13,287	13,026	\$32,248
ONO	12,705	12,424	\$28,321
SHARK	3,610	650	\$306
SHORTBILL SPEARFISH	556	505	\$399
GEAR = DEEP-SEA HANDLINE REGION = NORTHWESTERN H.I.			
STRIPED MARLIN	38	38	\$22
MAHIMAH I	31	31	\$57
SHORTBILL SPEARFISH	46	46	\$27

Table 9.--Continued.

GEAR = DEEP-SEA HANDLINE REGION = BEYOND 20 MILES			
SPECIES	LBCAUGHT	LBSOLD	REVENUE
BLUE MARLIN	490	490	\$122
MAHIMAH I	435	335	\$619
ONO	93	93	\$180
GEAR = DEEP-SEA HANDLINE REGION = OTHER			
MAHIMAH I	9	9	\$18
GEAR = INSHORE HANDLINE REGION = 0 TO 2 MILES			
ONO	22	--	--
SHARK	793	--	--
SHORTBILL SPEARFISH	54	54	\$24
GEAR = TROLLING LINE REGION = 0 TO 2 MILES			
STRIPED MARLIN	454	404	\$786
BLUE MARLIN	2,278	1,798	\$1,292
MAHIMAH I	5,447	4,888	\$12,660
ONO	7,420	6,599	\$16,916
BLACK MARLIN	320	320	\$192
GEAR = TROLLING LINE REGION = 2 TO 20 MILES			
STRIPED MARLIN	18,255	14,070	\$16,932
BLUE MARLIN	101,889	85,961	\$56,276
SAILFISH	260	180	\$183
MAHIMAH I	64,521	54,781	\$129,142
ONO	42,248	38,186	\$88,595
SHARK	550	--	--
HAMMERHEAD SHARK	200	--	--
SHORTBILL SPEARFISH	5,196	3,550	\$4,031
BLACK MARLIN	3,537	3,171	\$1,883
GEAR = TROLLING LINE REGION = NORTHWESTERN H.I.			
BLUE MARLIN	232	232	\$135
MAHIMAH I	104	104	\$442
ONO	2,537	2,537	\$5,023

Table 9.--Continued.

SPECIES	LBCAUGHT	LBSOLD	REVENUE
GEAR = TROLLING LINE REGION = BEYOND 20 MILES			
STRIPED MARLIN	69	69	\$67
BLUE MARLIN	962	962	\$940
MAHIMAH I	1,253	1,213	\$3,192
ONO	484	471	\$1,439
SHORTBILL SPEARFISH	81	51	\$53
GEAR = TROLLING LINE REGION = OTHER			
MAHIMAH I	13	13	\$27
ONO	213	213	\$606
GEAR = OTHER REGION = 0 TO 2 MILES			
MAHIMAH I	46	46	\$188
SHARK	1	1	\$1
GEAR = OTHER REGION = 2 TO 20 MILES			
MAHIMAH I	2,797	2,797	\$4,046
ONO	13	13	\$19
GEAR = OTHER REGION = BEYOND 20 MILES			
MAHIMAH I	317	317	\$984

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FEB 15 1984

National Marine Fisheries Service
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NATIONAL MARINE FISHERIES SERVICE

CROSS TABULATIONS OF CATCHES OF LARGE PELAGIC SPECIES BASED ON HAWAII COMMERCIAL CATCH REPORTS, JANUARY 1976 - APRIL 1981.

II. SPECIES BY AREA FISHED AND FISHING GEAR

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INTRODUCTION

In the first number of this series, we presented cross tabulations of the commercial catches of the Pelagic Species Management Unit in Hawaii to illustrate the variation and importance of various fishing areas and gears. Tables were presented for fishing areas containing summed catches by species and by fishing gears by species and then for fishing gears by species and by fishing areas by species.

In this paper, the emphasis is on species, namely the billfishes (Families Istiophoridae and Xiphiidae), mahimahi (Coryphaena sp.), wahoo, (Acanthocybium solandri), and sharks (Families Sphyrnidae and Carcharhinidae). Tables are set up by species and gear, then by species, gear, and area fished, and finally by species, area, and gear. The same data are presented in all of these tables. The different arrangements provide a different perspective for interpretation by the Plan Development Team and others associated with the development of a fishery management plan for these species.

Some explanation of the species names used in these tables is in order. Since the summaries are based on the statistics provided by the Division of Aquatic Resources, we have followed the naming conventions used by them. With respect to fish names: "swordfish" refers to billfish (Families Xiphiidae and Istiophoridae) or undifferentiated species, whereas "broadbill" is the swordfish (Xiphias gladius); "ono" is the Hawaiian name for wahoo (Acanthocybium solandri); sharks are divided into "hammerhead shark" (Sphyrna sp.) and "shark" (mostly Carcharhinidae) categories, both of which are mixtures of species. With respect to areas or regions, the State of Hawaii's fishery statistical zones are arranged in 0 to 2, 2 to 20, and beyond 20 nmi strata. Thus, it is not possible to summarize the data by 0 to 3 and 3 to 200 nmi zones without using some arbitrary approximating procedures. Also, catches from the Northwestern Hawaiian Islands (NWHI) can be differentiated from those in the main Hawaiian Islands, and we have chosen to do so in the following tables without regard to distance zones around the islands. With respect to fishing gear types, "flagline" refers to tuna longline fishing gear; "deep-sea handline" is generally a multi-hook gear fished in deep water for snappers whereas "inshore handline" gear is generally fished in shallower water for goatfish (the Mullidae), akule (bigeye scad, Selar crumenophthalmus), and other shallow water fishes; however, the distinction is not clear.

SPECIES BY GEAR

For striped marlin (Tetrapturus audax), flagline or tuna longline gear was the most important in 1976 through 1979, but by 1980, trolling gear accounted for most of the catches (Table 1). This change reflects an apparent increase in trolling activity and a decline in longline fishing or underreporting of catches by longline fishing.

For blue marlin (Makaira nigricans), trolling has contributed the greatest amount of catch, and again the data indicate that longline catches have become less important. Also, deep-sea handline catches have become progressively more important.

Reported catches of "broadbill" (swordfish) indicate that deep-sea handline has displaced longline as the most important gear for this species. The deep-sea handline category in the State of Hawaii's reporting system includes the night tuna (ika shibi) fishery.

Catches of sailfish (Istiophorus platypterus), shortbill spearfish (T. angustirostris), and black marlin (M. indica) are much less than the other billfish species, and trolling and flagline have been the most important fishing gears.

For mahimahi and ono, trolling line is the most important gear, but the proportion caught by deep-sea handline has increased, particularly for mahimahi.

For the shark category, the rank of the gear types has varied considerably with trolling and deep-sea handline catches becoming more important in later years.

SPECIES BY GEAR AND REGION

For striped marlin, catches by flagline and trolling line, the two most important gears have been greatest in the 2-20 nmi region (Table 2).

Catches of blue marlin by the most important gear, trolling line, have been largest in the 2-20 nmi area. This is true of the other gears as well.

Catches of "broadbill" have been greatest in the 2-20 nmi area for both flagline and deep-sea handline gear, and handline has recently displaced flagline as the most important gear.

For the sailfish, shortbill spearfish, and black marlin the 2-20 nmi zone has been the most important using trolling line.

The largest catches of mahimahi and ono have occurred in the 2-20 nmi region for trolling line and most other gears.

Shark catches exhibited no consistent fishing gear, nor regional pattern.

SPECIES BY REGION AND GEAR

For striped marlin in the 0-2 nmi zone, trolling line has consistently contributed the greatest catch and has replaced flagline as the most important in the 2-20 nmi zone (Table 3). In the greater than 20 nmi area, flagline remains the most important although the proportion of trolling catches have increased substantially. Catches in the NMHI were reported only in 1981.

For blue marlin in all areas, trolling line accounts for more catches than all the other fishing gears. Catches in the NWHI are reported for 1980 and 1981.

For "broadbill," the catches are relatively small and the importance of different gear types varies with region and year. In the greater than 20 nmi region, flagline has generally been the most important gear. In the 2-20 nmi region, deep-sea handline appears to have displaced flagline in importance. Catches in the NWHI are reported for only 1 year.

For sailfish the largest catches occur in the 2-20 nmi zone, and in this zone trolling line has contributed the greatest catch.

For mahimahi and ono in all zones, trolling line has been the most important gear except for the NWHI where deep-sea handline was sometimes more important. Catches are reported in the NWHI for all years for both species.

For shark, there is no consistent pattern in the contribution of various gear types by zone over these years.

For shortbill spearfish, the 2-20 nmi area is the most important, and flagline and trolling line are the most important gears in this area. In other areas, there is no consistent pattern of the importance of the various gears. Catches in the NWHI were reported in 1980 and 1981.

For black marlin, catches are significant only in the 2-20 nmi zones, and trolling line contributed the greatest catch in this area and generally in other areas as well.

II

TABLE 1.--HDAR 1976 DATA BY SPECIES AND GEAR.

GEAR	LB CAUGHT	LBSOLD	REVENUE
SPECIES = STRIPED MARLIN			
FLAGLINE	74,264	74,264	\$81,118
DEEP-SEA HANDLINE	12,339	11,386	\$4,420
INSHORE HANDLINE	79	79	\$98
TROLLING LINE	122,302	73,425	\$28,323
SPECIES = BLUE MARLIN			
FLAGLINE	16,751	16,751	\$12,089
DEEP-SEA HANDLINE	11,238	10,753	\$3,746
TROLLING LINE	163,231	104,584	\$36,470
SPECIES = BROADBILL			
FLAGLINE	429	429	\$174
DEEP-SEA HANDLINE	2,549	2,267	\$1,433
TROLLING LINE	543	543	\$451
SPECIES = SAILFISH			
FLAGLINE	584	584	\$270
DEEP-SEA HANDLINE	457	381	\$150
TROLLING LINE	1,302	711	\$274
SPECIES = MAHIMAH I			
FLAGLINE	16,461	16,461	\$30,004
DEEP-SEA HANDLINE	24,800	23,805	\$35,036
INSHORE HANDLINE	369	323	\$452
TROLLING LINE	90,065	63,423	\$100,788
OTHER	7,395	7,341	\$12,120
SPECIES = ONO			
FLAGLINE	7,536	7,536	\$6,410
DEEP-SEA HANDLINE	43,024	39,680	\$33,335
INSHORE HANDLINE	717	717	\$622
TROLLING LINE	118,128	87,187	\$86,678
OTHER	277	277	\$250
SPECIES = SHARK			
DEEP-SEA HANDLINE	349	0	\$0
TROLLING LINE	260	0	\$0
OTHER	769	9	\$7

Table 1.--Continued.

GEAR	LB CAUGHT	LB SOLD	REVENUE
SPECIES = HAMMERHEAD SHARK			
INSHORE HANDLINE	27	0	\$0
OTHER	135	0	\$0
SPECIES = SHORTBILL SPEARFISH			
FLAGLINE	7,037	7,037	\$5,093
DEEP-SEA HANDLINE	1,049	1,049	\$853
TROLLING LINE	5,636	3,127	\$1,427
SPECIES = BLACK MARLIN			
FLAGLINE	419	419	\$443
DEEP-SEA HANDLINE	1,003	1,003	\$163
TROLLING LINE	5,451	4,042	\$1,627

II TABLE 1.--HDAR 1977 DATA BY SPECIES AND GEAR.

GEAR	LBCAUGHT	LBSOLD	REVENUE
SPECIES = SWORDFISH			
TROLLING LINE	138	138	\$62
SPECIES = STRIPED MARLIN			
FLAGLINE	69,933	69,933	\$86,260
DEEP-SEA HANDLINE	1,327	1,284	\$1,199
INSHORE HANDLINE	100	100	\$100
TROLLING LINE	19,976	11,819	\$9,646
SPECIES = BLUE MARLIN			
FLAGLINE	24,626	24,626	\$19,470
DEEP-SEA HANDLINE	16,753	13,730	\$6,109
TROLLING LINE	324,841	235,129	\$83,937
SPECIES = BROADBILL			
FLAGLINE	36,965	36,965	\$64,218
DEEP-SEA HANDLINE	3,980	3,980	\$3,389
TROLLING LINE	290	290	\$323
SPECIES = SAILFISH			
FLAGLINE	734	734	\$694
DEEP-SEA HANDLINE	133	65	\$40
TROLLING LINE	518	358	\$251
OTHER	22	22	\$13
SPECIES = MAHIMAH I			
FLAGLINE	14,867	14,867	\$29,464
DEEP-SEA HANDLINE	18,250	17,291	\$27,198
INSHORE HANDLINE	454	439	\$669
TROLLING LINE	107,995	83,716	\$150,881
OTHER	8,754	8,729	\$15,587
SPECIES = ONO			
FLAGLINE	12,184	12,184	\$11,168
DEEP-SEA HANDLINE	29,178	28,343	\$28,118
INSHORE HANDLINE	1,029	974	\$946
TROLLING LINE	180,467	147,434	\$163,022
OTHER	570	550	\$560

Table 1.--Continued.

GEAR	LBCAUGHT	LBSOLD	REVENUE
SPECIES = SHARK			
DEEP-SEA HANDLINE	1,243	550	\$130
INSHORE HANDLINE	680	0	\$0
TROLLING LINE	561	161	\$32
OTHER	897	157	\$45
SPECIES = HAMMERHEAD SHARK			
OTHER	40	0	\$0
SPECIES = SHORTBILL SPEARFISH			
FLAGLINE	6,430	6,430	\$4,594
DEEP-SEA HANDLINE	473	396	\$163
TROLLING LINE	5,779	2,989	\$1,545
OTHER	81	81	\$66
SPECIES = BLACK MARLIN			
FLAGLINE	463	463	\$575
DEEP-SEA HANDLINE	730	557	\$332
TROLLING LINE	6,884	4,473	\$1,648

II TABLE 1.--HDAR 1978 DATA BY SPECIES AND GEAR.

GEAR	LB CAUGHT	LBS SOLD	REVENUE
SPECIES = STRIPED MARLIN			
FLAGLINE	105,271	105,271	\$145,366
DEEP-SEA HANDLINE	3,198	2,832	\$2,689
INSHORE HANDLINE	136	136	\$54
TROLLING LINE	38,416	27,927	\$26,543
SPECIES = BLUE MARLIN			
FLAGLINE	40,080	40,080	\$37,180
DEEP-SEA HANDLINE	12,144	11,797	\$5,225
INSHORE HANDLINE	1,114	1,114	\$465
TROLLING LINE	483,980	375,798	\$163,226
SPECIES = BROADBILL			
FLAGLINE	20,482	19,812	\$29,864
DEEP-SEA HANDLINE	9,056	9,056	\$10,340
INSHORE HANDLINE	47	47	\$47
TROLLING LINE	558	558	\$736
SPECIES = SAILFISH			
FLAGLINE	49	49	\$37
DEEP-SEA HANDLINE	113	113	\$85
TROLLING LINE	535	210	\$101
SPECIES = MAHIMAH			
FLAGLINE	10,422	10,422	\$23,285
DEEP-SEA HANDLINE	13,591	13,048	\$23,632
INSHORE HANDLINE	869	806	\$1,453
TROLLING LINE	96,616	76,578	\$151,238
OTHER	9,264	9,264	\$17,845
SPECIES = ONO			
FLAGLINE	10,173	10,173	\$13,153
DEEP-SEA HANDLINE	24,608	24,124	\$32,807
INSHORE HANDLINE	2,011	1,922	\$2,581
TROLLING LINE	158,056	131,077	\$176,667
OTHER	130	55	\$55

Table 1.--Continued.

GEAR	LB CAUGHT	LB SOLD	REVENUE
SPECIES = SHARK			
FLAGLINE	11,085	1,335	\$453
DEEP-SEA HANDLINE	4,122	1,436	\$542
INSHORE HANDLINE	531	166	\$72
TROLLING LINE	4,689	1,024	\$428
OTHER	243	43	\$2
SPECIES = HAMMERHEAD SHARK			
OTHER	1,527	--	--
SPECIES = SHORTBILL SPEARFISH			
FLAGLINE	11,168	11,168	\$12,639
DEEP-SEA HANDLINE	577	577	\$676
TROLLING LINE	12,974	8,051	\$6,391
SPECIES = BLACK MARLIN			
TROLLING LINE	1,368	424	\$434

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TABLE 1.--HDAR 1979 DATA BY SPECIES AND GEAR.

GEAR	LBCAUGHT	LBSOLD	REVENUE
SPECIES = SWORDFISH			
DEEP-SEA HANDLINE	2	--	--
SPECIES = STRIPED MARLIN			
FLAGLINE	71,861	71,861	\$104,071
DEEP-SEA HANDLINE	5,404	5,224	\$6,389
TROLLING LINE	33,974	25,899	\$26,891
OTHER	562	307	\$325
SPECIES = BLUE MARLIN			
FLAGLINE	15,228	15,228	\$16,043
DEEP-SEA HANDLINE	14,782	14,380	\$10,683
TROLLING LINE	406,566	320,255	\$149,130
OTHER	893	893	\$168
SPECIES = BROADBILL			
FLAGLINE	14,798	14,798	\$24,394
DEEP-SEA HANDLINE	13,790	13,775	\$18,952
TROLLING LINE	350	121	\$96
SPECIES = SAILFISH			
FLAGLINE	750	750	\$639
DEEP-SEA HANDLINE	176	176	\$168
TROLLING LINE	1,355	681	\$407
SPECIES = MAHIMAH			
FLAGLINE	7,845	7,821	\$16,249
DEEP-SEA HANDLINE	23,639	22,408	\$41,691
INSHORE HANDLINE	101	80	\$127
TROLLING LINE	132,582	110,337	\$217,912
OTHER	10,381	10,336	\$17,770
SPECIES = ONO			
FLAGLINE	3,512	3,512	\$7,077
DEEP-SEA HANDLINE	21,895	20,971	\$35,364
INSHORE HANDLINE	282	232	\$361
TROLLING LINE	174,168	47,329	\$262,802
OTHER	122	97	\$209

Table 1.--Continued.

GEAR	LB CAUGHT	LB SOLD	REVENUE
SPECIES = SHARK			
FLAGLINE	1,405	1,405	\$585
DEEP-SEA HANDLINE	190	--	--
INSHORE HANDLINE	58	--	--
TROLLING LINE	1,615	304	\$43
OTHER	1,161	164	\$89
SPECIES = HAMMERHEAD SHARK			
TROLLING LINE	150	--	--
OTHER	1,880	--	--
SPECIES = SHORTBILL SPEARFISH			
FLAGLINE	4,369	4,369	\$5,245
DEEP-SEA HANDLINE	455	435	\$385
TROLLING LINE	11,671	7,964	\$8,829
OTHER	759	679	\$669
SPECIES = BLACK MARLIN			
FLAGLINE	244	244	\$282
DEEP-SEA HANDLINE	1,835	1,487	\$1,423
TROLLING LINE	9,061	6,429	\$3,011

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TABLE 1.--HDAR 1980 DATA BY SPECIES AND GEAR.

GEAR	LBCAUGHT	LBSOLD	REVENUE
SPECIES = STRIPED MARLIN			
FLAGLINE	24,414	24,414	\$28,140
DEEP-SEA HANDLINE	4,305	4,206	\$6,018
TROLLING LINE	38,247	30,090	\$36,015
SPECIES = BLUE MARLIN			
FLAGLINE	8,704	8,704	\$7,680
DEEP-SEA HANDLINE	26,389	24,074	\$13,868
TROLLING LINE	405,787	349,258	\$168,863
OTHER	650	650	\$195
SPECIES = BROADBILL			
FLAGLINE	695	695	\$1,238
DEEP-SEA HANDLINE	30,807	30,480	\$41,116
TROLLING LINE	1,032	1,032	\$1,219
OTHER	490	490	\$515
SPECIES = SAILFISH			
DEEP-SEA HANDLINE	447	407	\$416
TROLLING LINE	510	272	\$182
SPECIES = MAHIMAH I			
FLAGLINE	8,852	8,784	\$18,527
DEEP-SEA HANDLINE	40,872	39,501	\$87,169
INSHORE HANDLINE	105	94	\$240
TROLLING LINE	180,281	154,688	\$333,762
OTHER	8,550	8,550	\$16,321
SPECIES = ONO			
FLAGLINE	2,595	2,595	\$4,602
DEEP-SEA HANDLINE	40,343	39,202	\$76,334
INSHORE HANDLINE	48	44	\$37
TROLLING LINE	223,035	196,497	\$370,600
OTHER	415	385	\$589

Table 1.--Continued.

GEAR	LBCAUGHT	LBSOLD	REVENUE
SPECIES = SHARK			
FLAGLINE	270	270	\$102
DEEP-SEA HANDLINE	5,257	241	\$90
INSHORE HANDLINE	1,333	13	\$6
TROLLING LINE	4,751	200	\$50
OTHER	621	21	\$12
SPECIES = HAMMERHEAD SHARK			
TROLLING LINE	219	120	\$35
OTHER	225	225	\$96
SPECIES = SHORTBILL SPEARFISH			
FLAGLINE	320	320	\$256
DEEP-SEA HANDLINE	642	515	\$468
INSHORE HANDLINE	6	6	\$8
TROLLING LINE	11,029	8,281	\$7,421
OTHER	1	1	\$1
SPECIES = BLACK MARLIN			
DEEP-SEA HANDLINE	527	249	\$447
TROLLING LINE	5,333	4,895	\$3,344
OTHER	10	4	\$2

II TABLE 1.--HDAR 1981 DATA BY SPECIES AND GEAR.

GEAR	LBCAUGHT	LBSOLD	REVENUE
SPECIES = STRIPED MARLIN			
FLAGLINE	11,659	11,659	\$14,234
DEEP-SEA HANDLINE	673	670	\$734
TROLLING LINE	18,778	14,543	\$17,785
SPECIES = BLUE MARLIN			
FLAGLINE	2,055	2,055	\$1,893
DEEP-SEA HANDLINE	6,468	5,772	\$5,692
TROLLING LINE	105,361	88,953	\$58,643
SPECIES = BROADBILL			
FLAGLINE	26	26	\$14
DEEP-SEA HANDLINE	1,635	1,581	\$2,755
SPECIES = SAILFISH			
FLAGLINE	103	103	\$85
DEEP-SEA HANDLINE	21	21	\$15
TROLLING LINE	260	180	\$183
SPECIES = MAHIMAH I			
FLAGLINE	3,103	3,058	\$7,335
DEEP-SEA HANDLINE	15,252	14,821	\$36,563
TROLLING LINE	71,338	60,999	\$145,463
OTHER	3,160	3,160	\$5,218
SPECIES = ONO			
FLAGLINE	497	497	\$1,231
DEEP-SEA HANDLINE	13,700	13,360	\$30,219
INSHORE HANDLINE	22	--	--
TROLLING LINE	52,902	48,006	\$112,579
OTHER	13	13	\$19
SPECIES = SHARK			
DEEP-SEA HANDLINE	3,891	650	\$306
INSHORE HANDLINE	793	--	--
TROLLING LINE	550	--	--
OTHER	1	1	\$1
SPECIES = HAMMERHEAD SHARK			
TROLLING LINE	200	--	--

Table 1.--Continued.

GEAR	LB CAUGHT	LB SOLD	REVENUE
SPECIES = SHORTBILL SPEARFISH			
FLAGLINE	67	67	\$50
DEEP-SEA HANDLINE	602	551	\$426
INSHORE HANDLINE	54	54	\$24
TROLLING LINE	5,277	3,601	\$4,084
SPECIES = BLACK MARLIN			
TROLLING LINE	3,857	3,491	\$2,075

II TABLE 2.--HDAR 1976 DATA BY SPECIES, GEAR, AND REGION.

REGION	LBCAUGHT	LBSOLD	REVENUE
SPECIES = STRIPED MARLIN GEAR = FLAGLINE			
0 TO 2 MILES	708	708	\$820
2 TO 20 MILES	67,317	67,317	\$71,689
BEYOND 20 MILES	6,239	6,239	\$8,609
SPECIES = STRIPED MARLIN GEAR = DEEP SEA HANDLINE			
0 TO 2 MILES	1,002	1,002	\$181
2 TO 20 MILES	10,895	9,942	\$3,841
BEYOND 20 MILES	442	442	\$398
SPECIES = STRIPED MARLIN GEAR = INSHORE HANDLINE			
0 TO 2 MILES	79	79	\$98
SPECIES = STRIPED MARLIN GEAR = TROLLING LINE			
0 TO 2 MILES	5,145	3,115	\$1,017
2 TO 20 MILES	115,602	68,775	\$26,081
BEYOND 20 MILES	1,485	1,485	\$1,150
OTHER	70	50	\$75
SPECIES = BLUE MARLIN GEAR = FLAGLINE			
0 TO 20 MILES	14,553	14,553	\$10,739
BEYOND 20 MILES	2,198	2,198	\$1,351
SPECIES = BLUE MARLIN GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	490	189	\$38
2 TO 20 MILES	10,748	10,564	\$3,708
SPECIES = BLUE MARLIN GEAR = TROLLING LINE			
0 TO 2 MILES	4,543	3,835	\$1,267
2 TO 20 MILES	154,514	97,079	\$33,522
BEYOND 20 MILES	4,174	3,670	\$1,681
SPECIES = BROADBILL GEAR = FLAGLINE			
2 TO 20 MILES	429	429	\$174
SPECIES = BROADBILL GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	103	103	\$52
2 TO 20 MILES	2,356	2,074	\$1,337
BEYOND 20 MILES	90	90	\$45

Table 2.--Continued.

REGION	LBCAUGHT	LBSOLD	REVENUE
SPECIES = BROADBILL GEAR = TROLLING LINE			
2 TO 20 MILES	543	543	\$451
SPECIES = SAILFISH GEAR = FLAGLINE			
2 TO 20 MILES	529	529	\$253
BEYOND 20 MILES	55	55	\$17
SPECIES = SAILFISH GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	46	46	\$14
2 TO 20 MILES	235	159	\$41
BEYOND 20 MILES	176	176	\$95
SPECIES = SAILFISH GEAR = TROLLING LINE			
0 TO 2 MILES	98	98	\$23
2 TO 20 MILES	1,204	613	\$251
SPECIES = MAHIMAH I GEAR = FLAGLINE			
2 TO 20 MILES	15,087	15,087	\$27,553
BEYOND 20 MILES	1,374	1,374	\$2,450
SPECIES = MAHIMAH I GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	992	820	\$1,112
2 TO 20 MILES	22,526	21,703	\$32,091
NORTHWESTERN H.I.	67	67	\$93
BEYOND 20 MILES	1,215	1,215	\$1,741
SPECIES = MAHIMAH I GEAR = INSHORE HANDLINE			
0 TO 2 MILES	262	216	\$316
2 TO 20 MILES	107	107	\$137
SPECIES = MAHIMAH I GEAR = TROLLING LINE			
0 TO 2 MILES	4,644	3,178	\$4,595
2 TO 20 MILES	82,987	58,340	\$92,483
BEYOND 20 MILES	2,332	1,818	\$3,579
OTHER	102	87	\$131

Table 2.--Continued.

REGION	LBCAUGHT	LBSOLD	REVENUE
SPECIES = MAHIMAH I GEAR = OTHER			
0 TO 2 MILES	305	303	\$377
2 TO 20 MILES	5,958	5,906	\$10,205
BEYOND 20 MILES	1,132	1,132	\$1,538
SPECIES = ONO GEAR = FLAGLINE			
2 TO 20 MILES	5,843	5,843	\$5,120
BEYOND 20 MILES	1,693	1,693	\$1,290
SPECIES = ONO GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	2,418	2,398	\$2,146
2 TO 20 MILES	32,202	28,908	\$24,969
NORTHWESTERN H.I.	8,200	8,200	\$6,082
BEYOND 20 MILES	204	174	\$138
SPECIES = ONO GEAR = INSHORE HANDLINE			
0 TO 2 MILES	547	547	\$458
2 TO 20 MILES	170	170	\$164
SPECIES = ONO GEAR = TROLLING LINE			
0 TO 2 MILES	19,220	15,321	\$16,565
2 TO 20 MILES	98,587	71,550	\$69,846
BEYOND 20 MILES	265	260	\$228
OTHER	56	56	\$39
SPECIES = ONO GEAR = OTHER			
2 TO 20 MILES	277	277	\$250
SPECIES = SHARK GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	10	0	\$0
2 TO 20 MILES	339	0	\$0
SPECIES = SHARK GEAR = TROLLING LINE			
2 TO 20 MILES	260	0	\$0

Table 2.--Continued.

REGION	LBCAUGHT	LBSOLD	REVENUE
	SPECIES = SHARK	GEAR = OTHER	
0 TO 2 MILES	760	0	\$0
2 TO 20 MILES	9	9	\$7
	SPECIES = HAMMERHEAD SHARK	GEAR = INSHORE HANDLINE	
0 TO 2 MILES	27	0	\$0
	SPECIES = HAMMERHEAD SHARK	GEAR = OTHER	
0 TO 2 MILES	135	0	\$0
	SPECIES = SHORTBILL SPEARFISH	GEAR = FLAGLINE	
2 TO 20 MILES	5,692	5,692	\$4,067
BEYOND 20 MILES	1,345	1,345	\$1,026
	SPECIES = SHORTBILL SPEARFISH	GEAR = DEEP-SEA HANDLINE	
2 TO 20 MILES	395	395	\$189
BEYOND 20 MILES	654	654	\$664
	SPECIES = SHORTBILL SPEARFISH	GEAR = TROLLING LINE	
0 TO 2 MILES	414	65	\$89
2 TO 20 MILES	5,141	2,985	\$1,319
BEYOND 20 MILES	81	77	\$19
	SPECIES = BLACK MARLIN	GEAR = FLAGLINE	
2 TO 20 MILES	419	419	\$443
	SPECIES = BLACK MARLIN	GEAR = DEEP-SEA HANDLINE	
2 TO 20 MILES	1,003	1,003	\$163
	SPECIES = BLACK MARLIN	GEAR = TROLLING LINE	
2 TO 20 MILES	5,054	3,645	\$1,330
BEYOND 20 MILES	397	397	\$297

II TABLE 2.--HDAR 1977 DATA BY SPECIES, GEAR, AND REGION.

REGION	LBCAUGHT	LBSOLD	REVENUE
SPECIES = SWORDFISH GEAR = TROLLING LINE			
2 TO 20 MILES	138	138	\$62
SPECIES = STRIPED MARLIN GEAR = FLAGLINE			
2 TO 20 MILES	64,772	64,772	\$79,657
BEYOND 20 MILES	5,161	5,161	\$6,603
SPECIES = STRIPED MARLIN GEAR = DEEP-SEA HANDLINE			
2 TO 20 MILES	1,217	1,174	\$1,095
BEYOND 20 MILES	110	110	\$105
SPECIES = STRIPED MARLIN GEAR = INSHORE HANDLINE			
2 TO 20 MILES	100	100	\$100
SPECIES = STRIPED MARLIN GEAR = TROLLING LINE			
0 TO 2 MILES	622	566	\$290
2 TO 20 MILES	18,923	10,922	\$9,086
BEYOND 20 MILES	381	331	\$270
OTHER	50	0	\$0
SPECIES = BLUE MARLIN GEAR = FLAGLINE			
2 TO 20 MILES	22,523	22,523	\$17,834
BEYOND 20 MILES	2,103	2,103	\$1,636
SPECIES = BLUE MARLIN GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	895	534	\$333
2 TO 20 MILES	15,858	13,196	\$5,776
SPECIES = BLUE MARLIN GEAR = TROLLING LINE			
0 TO 2 MILES	6,810	3,641	\$1,252
2 TO 20 MILES	314,008	228,526	\$81,502
BEYOND 20 MILES	4,023	2,962	\$1,183
SPECIES = BROADBILL GEAR = FLAGLINE			
2 TO 20 MILES	35,362	35,362	\$61,388
BEYOND 20 MILES	1,603	1,603	\$2,830

Table 2.--Continued.

REGION	LBCAUGHT	LBSOLD	REVENUE
SPECIES = BROADBILL GEAR = DEEP-SEA HANDLINE			
2 TO 20 MILES	3,756	3,756	\$3,191
BEYOND 20 MILES	224	224	\$198
SPECIES = BROADBILL GEAR = TROLLING LINE			
2 TO 20 MILES	290	290	\$323
SPECIES = SAILFISH GEAR = FLAGLINE			
2 TO 20 MILES	620	620	\$626
BEYOND 20 MILES	114	114	\$69
SPECIES = SAILFISH GEAR = DEEP-SEA HANDLINE			
2 TO 20 MILES	107	39	\$23
BEYOND 20 MILES	26	26	\$17
SPECIES = SAILFISH GEAR = TROLLING LINE			
0 TO 2 MILES	135	135	\$119
2 TO 20 MILES	376	223	\$133
BEYOND 20 MILES	7	0	\$0
SPECIES = SAILFISH GEAR = OTHER			
2 TO 20 MILES	22	22	\$13
SPECIES = MAHIMAH I GEAR = FLAGLINE			
0 TO 2 MILES	55	55	\$83
2 TO 20 MILES	13,805	13,805	\$27,620
BEYOND 20 MILES	1,007	1,007	\$1,761
SPECIES = MAHIMAH I GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	1,817	1,757	\$2,607
2 TO 20 MILES	15,462	14,563	\$22,993
BEYOND 20 MILES	971	971	\$1,598
SPECIES = MAHIMAH I GEAR = INSHORE HANDLINE			
0 TO 2 MILES	226	211	\$369
2 TO 20 MILES	228	228	\$299

Table 2.--Continued.

REGION	LB CAUGHT	LBS SOLD	REVENUE
SPECIES = MAHIMAH I GEAR = TROLLING LINE			
0 TO 2 MILES	5,955	4,807	\$6,714
2 TO 20 MILES	100,538	77,578	\$141,838
NORTHWESTERN H.I.	20	20	\$30
BEYOND 20 MILES	1,482	1,311	\$2,299
SPECIES = MAHIMAH I GEAR = OTHER			
0 TO 2 MILES	293	293	\$480
2 TO 20 MILES	5,696	5,671	\$10,564
BEYOND 20 MILES	2,765	2,765	\$4,543
SPECIES = ONO GEAR = FLAGLINE			
2 TO 20 MILES	11,316	11,316	\$10,204
BEYOND 20 MILES	868	868	\$963
SPECIES = ONO GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	3,202	3,202	\$2,810
2 TO 20 MILES	24,237	23,402	\$23,408
NORTHWESTERN H.I.	612	612	\$817
BEYOND 20 MILES	1,127	1,127	\$1,082
SPECIES = ONO GEAR = INSHORE HANDLINE			
0 TO 2 MILES	224	224	\$196
2 TO 20 MILES	805	750	\$750
SPECIES = ONO GEAR = TROLLING LINE			
0 TO 2 MILES	26,730	23,109	\$26,810
2 TO 20 MILES	151,358	122,348	\$134,072
NORTHWESTERN H.I.	1,055	1,055	\$858
BEYOND 20 MILES	1,070	668	\$1,011
OTHER	254	254	\$270
SPECIES = ONO GEAR = OTHER			
0 TO 2 MILES	182	182	\$182
2 TO 20 MILES	380	360	\$372
BEYOND 20 MILES	8	8	\$6
SPECIES = SHARK GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	548	134	\$18
2 TO 20 MILES	695	416	\$112

Table 2.--Continued.

REGION	LBCAUGHT	LBSOLD	REVENUE
SPECIES = SHARK GEAR = INSHORE HANDLINE			
0 TO 2 MILES	450	0	\$0
BEYOND 20 MILES	230	0	\$0
SPECIES = SHARK GEAR = TROLLING LINE			
0 TO 2 MILES	100	0	\$0
2 TO 20 MILES	461	161	\$32
SPECIES = SHARK GEAR = OTHER			
0 TO 2 MILES	543	3	\$0
2 TO 20 MILES	354	154	\$45
SPECIES = HAMMERHEAD SHARK GEAR = OTHER			
0 TO 2 MILES	40	0	\$0
SPECIES = SHORTBILL SPEARFISH GEAR = FLAGLINE			
2 TO 20 MILES	6,133	6,133	\$4,419
BEYOND 20 MILES	297	297	\$175
SPECIES = SHORTBILL SPEARFISH GEAR = DEEP-SEA HANDLINE			
2 TO 20 MILES	473	396	\$163
SPECIES = SHORTBILL SPEARFISH GEAR = TROLLING LINE			
0 TO 2 MILES	74	74	\$47
2 TO 20 MILES	5,676	2,886	\$1,449
BEYOND 20 MILES	29	29	\$49
SPECIES = SHORTBILL SPEARFISH GEAR = OTHER			
0 TO 2 MILES	81	81	\$66
SPECIES = BLACK MARLIN GEAR = FLAGLINE			
2 TO 20 MILES	258	258	\$401
BEYOND 20 MILES	205	205	\$174
SPECIES = BLACK MARLIN GEAR = DEEP SEA HANDLINE			
2 TO 20 MILES	730	557	\$332

Table 2.--Continued.

REGION	LBCAUGHT	LBSOLD	REVENUE
	SPECIES = BLACK MARLIN	GEAR = TROLLING LINE	
2 TO 20 MILES	5,606	3,195	\$1,132
BEYOND 20 MILES	1,278	1,278	\$516

II TABLE 2.--HDAR 1978 DATA BY SPECIES, GEAR, AND REGION.

REGION	LBCAUGHT	LBSOLD	REVENUE
SPECIES = STRIPED MARLIN GEAR = FLAGLINE			
2 TO 20 MILES	87,889	87,889	\$124,052
BEYOND 20 MILES	17,382	17,382	\$21,314
SPECIES = STRIPED MARLIN GEAR = DEEP-SEA HANDLINE			
2 TO 20 MILES	2,613	2,287	\$2,280
BEYOND 20 MILES	585	545	\$409
SPECIES = STRIPED MARLIN GEAR = INSHORE HANDLINE			
0 TO 2 MILES	136	136	\$54
SPECIES = STRIPED MARLIN GEAR = TROLLING LINE			
0 TO 2 MILES	497	337	\$279
2 TO 20 MILES	36,752	26,545	\$25,476
BEYOND 20 MILES	1,167	1,045	\$789
SPECIES = BLUE MARLIN GEAR = FLAGLINE			
2 TO 20 MILES	34,622	34,622	\$32,643
BEYOND 20 MILES	5,458	5,458	\$4,536
SPECIES = BLUE MARLIN GEAR = DEEP-SEA HANDLINE			
2 TO 20 MILES	11,156	10,809	\$4,945
BEYOND 20 MILES	988	988	\$280
SPECIES = BLUE MARLIN GEAR = INSHORE HANDLINE			
0 TO 2 MILES	1,114	1,114	\$465
SPECIES = BLUE MARLIN GEAR = TROLLING LINE			
0 TO 2 MILES	6,863	3,822	\$1,716
2 TO 20 MILES	464,326	360,320	\$157,749
BEYOND 20 MILES	12,791	11,656	\$3,761
SPECIES = BROADBILL GEAR = FLAGLINE			
2 TO 20 MILES	11,952	11,282	\$17,181
BEYOND 20 MILES	8,530	8,530	\$12,683

Table 2.--Continued.

REGION	LBCAUGHT	LBSOLD	REVENUE
SPECIES = BROADBILL GEAR = DEEP-SEA HANDLINE			
2 TO 20 MILES	8,916	8,916	\$10,235
BEYOND 20 MILES	140	140	\$105
SPECIES = BROADBILL GEAR = INSHORE HANDLINE			
0 TO 2 MILES	47	47	\$47
SPECIES = BROADBILL GEAR = TROLLING LINE			
2 TO 20 MILES	558	558	\$736
SPECIES = SAILFISH GEAR = FLAGLINE			
2 TO 20 MILES	49	49	\$37
SPECIES = SAILFISH GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	70	70	\$70
2 TO 20 MILES	43	43	\$15
SPECIES = SAILFISH GEAR = TROLLING LINE			
2 TO 20 MILES	535	210	\$101
SPECIES = MAHIMAH I GEAR = FLAGLINE			
0 TO 2 MILES	881	881	\$1,469
2 TO 20 MILES	7,449	7,449	\$17,480
BEYOND 20 MILES	2,092	2,092	\$4,336
SPECIES = MAHIMAH I GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	307	307	\$486
2 TO 20 MILES	12,654	12,111	\$22,111
NORTHWESTERN H.I.	118	118	\$192
BEYOND 20 MILES	512	512	\$843
SPECIES = MAHIMAH I GEAR = INSHORE HANDLINE			
0 TO 2 MILES	850	787	\$1,424
2 TO 20 MILES	19	19	\$29

Table 2.--Continued.

REGION	LBCAUGHT	LBSOLD	REVENUE
SPECIES = MAHIMAHI GEAR = TROLLING LINE			
0 TO 2 MILES	3,898	2,984	\$4,908
2 TO 20 MILES	91,774	72,874	\$144,685
BEYOND 20 MILES	772	548	\$1,274
OTHER	172	172	\$371
SPECIES = MAHIMAHI GEAR = OTHER			
0 TO 2 MILES	4	4	\$6
2 TO 20 MILES	8,732	8,732	\$16,600
BEYOND 20 MILES	514	514	\$1,201
OTHER	14	14	\$38
SPECIES = ONO GEAR = FLAGLINE			
0 TO 2 MILES	534	534	\$775
2 TO 20 MILES	7,722	7,722	\$9,701
BEYOND 20 MILES	1,917	1,917	\$2,677
SPECIES = ONO GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	411	386	\$490
2 TO 20 MILES	21,887	21,438	\$27,124
BEYOND 20 MILES	314	304	\$354
SPECIES = ONO GEAR = INSHORE HANDLINE			
0 TO 2 MILES	1,943	1,888	\$2,529
2 TO 20 MILES	68	34	\$53
SPECIES = ONO GEAR = TROLLING LINE			
0 TO 2 MILES	13,951	11,303	\$16,131
2 TO 20 MILES	140,566	116,466	\$156,433
BEYOND 20 MILES	1,626	1,395	\$1,945
OTHER	1,913	1,913	\$2,157
SPECIES = ONO GEAR = OTHER			
0 TO 2 MILES	43	0	\$0
2 TO 20 MILES	87	55	\$55
SPECIES = SHARK GEAR = FLAGLINE			
2 TO 20 MILES	11,085	1,335	\$453

Table 2.--Continued.

REGION	LB CAUGHT	LBS SOLD	REVENUE
SPECIES = SHARK GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	300	72	\$25
2 TO 20 MILES	3,740	1,282	\$472
BEYOND 20 MILES	82	82	\$44
SPECIES = SHARK GEAR = INSHORE HANDLINE			
0 TO 2 MILES	531	166	\$72
SPECIES = SHARK GEAR = TROLLING LINE			
0 TO 2 MILES	1,525	60	\$35
2 TO 20 MILES	3,164	964	\$393
SPECIES = SHARK GEAR = OTHER			
0 TO 2 MILES	243	43	\$2
SPECIES = HAMMERHEAD SHARK GEAR = OTHER			
0 TO 2 MILES	1,527	--	--
SPECIES = SHORTBILL SPEARFISH GEAR = FLAGLINE			
2 TO 20 MILES	9,719	9,719	\$11,023
BEYOND 20 MILES	1,449	1,449	\$1,616
SPECIES = SHORTBILL SPEARFISH GEAR = DEEP-SEA HANDLINE			
2 TO 20 MILES	577	577	\$676
SPECIES = SHORTBILL SPEARFISH GEAR = TROLLING LINE			
2 TO 20 MILES	12,637	7,744	\$6,109
BEYOND 20 MILES	337	307	\$282
SPECIES = BLACK MARLIN GEAR = TROLLING LINE			
2 TO 20 MILES	1,368	424	\$434

II TABLE 2.--HDAR 1979 DATA BY SPECIES, GEAR, AND REGION.

REGION	LBCAUGHT	LBSOLD	REVENUE
SPECIES = SWORDFISH GEAR = DEEP-SEA HANDLINE			
2 TO 20 MILES	2	--	--
SPECIES = STRIPED MARLIN GEAR = FLAGLINE			
2 TO 20 MILES	66,510	66,510	\$94,880
BEYOND 20 MILES	4,954	4,954	\$8,903
OTHER	397	397	\$288
SPECIES = STRIPED MARLIN GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	286	216	\$115
2 TO 20 MILES	4,474	4,364	\$5,493
BEYOND 20 MILES	644	644	\$781
SPECIES = STRIPED MARLIN GEAR = TROLLING LINE			
0 TO 2 MILES	989	837	\$992
2 TO 20 MILES	32,110	24,362	\$25,454
BEYOND 20 MILES	875	700	\$445
SPECIES = STRIPED MARLIN GEAR = OTHER			
2 TO 20 MILES	330	75	\$172
BEYOND 20 MILES	232	232	\$153
SPECIES = BLUE MARLIN GEAR = FLAGLINE			
2 TO 20 MILES	13,747	13,747	\$14,536
BEYOND 20 MILES	1,481	1,481	\$1,507
SPECIES = BLUE MARLIN GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	705	705	\$436
2 TO 20 MILES	12,508	12,211	\$8,980
BEYOND 20 MILES	1,569	1,464	\$1,267
SPECIES = BLUE MARLIN GEAR = TROLLING LINE			
0 TO 2 MILES	18,386	14,922	\$6,171
2 TO 20 MILES	374,958	294,078	\$138,877
BEYOND 20 MILES	13,042	11,255	\$4,082
OTHER	180	--	--

Table 2.--Continued.

REGION	LB CAUGHT	LB SOLD	REVENUE
SPECIES = BLUE MARLIN GEAR = OTHER			
2 TO 20 MILES	659	659	\$98
BEYOND 20 MILES	234	234	\$70
SPECIES = BROADBILL GEAR = FLAGLINE			
2 TO 20 MILES	14,278	14,278	\$23,566
BEYOND 20 MILES	220	220	\$330
OTHER	300	300	\$498
SPECIES = BROADBILL GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	827	812	\$1,152
2 TO 20 MILES	12,201	12,201	\$16,812
NORTHWESTERN H.I.	141	141	\$176
BEYOND 20 MILES	621	621	\$812
SPECIES = BROADBILL GEAR = TROLLING LINE			
2 TO 20 MILES	350	121	\$96
SPECIES = SAILFISH GEAR = FLAGLINE			
2 TO 20 MILES	677	677	\$597
BEYOND 20 MILES	73	73	\$42
SPECIES = SAILFISH GEAR = DEEP-SEA HANDLINE			
2 TO 20 MILES	99	99	\$82
BEYOND 20 MILES	77	77	\$86
SPECIES = SAILFISH GEAR = TROLLING LINE			
0 TO 2 MILES	152	77	\$56
2 TO 20 MILES	1,203	604	\$351
SPECIES = MAHIMAHU GEAR = FLAGLINE			
0 TO 2 MILES	510	510	\$920
2 TO 20 MILES	6,508	6,508	\$13,655
BEYOND 20 MILES	553	553	\$1,054
OTHER	274	250	\$620

Table 2.--Continued.

REGION	LBCAUGHT	LBSOLD	REVENUE
SPECIES = MAHIMAHI GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	2,314	2,061	\$3,261
2 TO 20 MILES	19,285	18,307	\$34,539
BEYOND 20 MILES	2,040	2,040	\$3,891
SPECIES = MAHIMAHI GEAR = INSHORE HANDLINE			
0 TO 2 MILES	87	80	\$127
2 TO 20 MILES	14	--	--
SPECIES = MAHIMAHI GEAR = TROLLING LINE			
0 TO 2 MILES	6,399	4,960	\$9,263
2 TO 20 MILES	124,447	104,039	\$206,138
NORTHWESTERN H.I.	30	30	\$30
BEYOND 20 MILES	1,395	997	\$1,834
OTHER	311	311	\$647
SPECIES = MAHIMAHI GEAR = OTHER			
0 TO 2 MILES	98	98	\$203
2 TO 20 MILES	6,492	6,447	\$12,328
BEYOND 20 MILES	3,754	3,754	\$5,205
OTHER	37	37	\$34
SPECIES = ONO GEAR = FLAGLINE			
0 TO 2 MILES	29	29	\$59
2 TO 20 MILES	2,741	2,741	\$5,247
BEYOND 20 MILES	445	445	\$1,206
OTHER	297	297	\$565
SPECIES = ONO GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	4,135	3,968	\$6,140
2 TO 20 MILES	16,826	16,148	\$27,170
NORTHWESTERN H.I.	96	96	\$133
BEYOND 20 MILES	833	759	\$1,921
OTHER	5	--	--
SPECIES = ONO GEAR = INSHORE HANDLINE			
0 TO 2 MILES	282	232	\$361

Table 2.--Continued.

REGION	LB CAUGHT	LBS SOLD	REVENUE
SPECIES = ONO GEAR = TROLLING LINE			
0 TO 2 MILES	27,982	23,658	\$43,499
2 TO 20 MILES	136,589	114,537	\$199,021
NORTHWESTERN H.I.	7,094	7,094	\$16,001
BEYOND 20 MILES	1,285	822	\$1,256
OTHER	1,218	1,218	\$3,025
SPECIES = ONO GEAR = OTHER			
0 TO 2 MILES	28	28	\$65
2 TO 20 MILES	52	27	\$71
BEYOND 20 MILES	42	42	\$73
SPECIES = SHARK GEAR = FLAGLINE			
2 TO 20 MILES	871	871	\$397
BEYOND 20 MILES	534	534	\$188
SPECIES = SHARK GEAR = DEEP-SEA HANDLINE			
2 TO 20 MILES	190	--	--
SPECIES = SHARK GEAR = INSHORE HANDLINE			
0 TO 2 MILES	58	--	--
SPECIES = SHARK GEAR = TROLLING LINE			
0 TO 2 MILES	66	66	\$6
2 TO 20 MILES	1,549	238	\$37
SPECIES = SHARK GEAR = OTHER			
0 TO 2 MILES	1,026	29	\$48
2 TO 20 MILES	135	135	\$41
SPECIES = HAMMERHEAD SHARK GEAR = TROLLING LINE			
2 TO 20 MILES	150	--	--
SPECIES = HAMMERHEAD SHARK GEAR = OTHER			
0 TO 2 MILES	1,880	--	--

Table 2.--Continued.

REGION	LBCAUGHT	LBSOLD	REVENUE
SPECIES = SHORTBILL SPEARFISH GEAR = FLAGLINE			
2 TO 20 MILES	3,747	3,747	\$4,422
BEYOND 20 MILES	622	622	\$823
SPECIES = SHORTBILL SPEARFISH GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	45	45	\$56
2 TO 20 MILES	410	390	\$329
SPECIES = SHORTBILL SPEARFISH GEAR = TROLLING LINE			
0 TO 2 MILES	391	391	\$298
2 TO 20 MILES	11,013	7,425	\$8,383
BEYOND 20 MILES	229	110	\$129
OTHER	38	38	\$19
SPECIES = SHORTBILL SPEARFISH GEAR = OTHER			
0 TO 2 MILES	729	679	\$669
BEYOND 20 MILES	30	--	--
SPECIES = BLACK MARLIN GEAR = FLAGLINE			
2 TO 20 MILES	100	100	\$98
OTHER	144	144	\$184
SPECIES = BLACK MARLIN GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	202	202	\$101
2 TO 20 MILES	1,633	1,285	\$1,322
SPECIES = BLACK MARLIN GEAR = TROLLING LINE			
2 TO 20 MILES	8,618	6,111	\$2,860
BEYOND 20 MILES	443	318	\$151

II TABLE 2.--HDAR 1980 DATA BY SPECIES, GEAR, AND REGION.

REGION	LBCAUGHT	LBSOLD	REVENUE
SPECIES = STRIPED MARLIN GEAR = FLAGLINE			
2 TO 20 MILES	19,875	19,875	\$22,815
BEYOND 20 MILES	4,539	4,539	\$5,325
SPECIES = STRIPED MARLIN GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	449	449	\$337
2 TO 20 MILES	2,466	2,367	\$3,085
BEYOND 20 MILES	1,390	1,390	\$2,596
SPECIES = STRIPED MARLIN GEAR = TROLLING LINE			
0 TO 2 MILES	1,455	1,306	\$1,742
2 TO 20 MILES	36,229	28,261	\$33,679
BEYOND 20 MILES	486	446	\$496
OTHER	77	77	\$98
SPECIES = BLUE MARLIN GEAR = FLAGLINE			
2 TO 20 MILES	6,870	6,870	\$5,920
BEYOND 20 MILES	1,834	1,834	\$1,760
SPECIES = BLUE MARLIN GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	4,634	3,910	\$1,755
2 TO 20 MILES	20,565	18,974	\$10,971
BEYOND 20 MILES	1,190	1,190	\$1,142
SPECIES = BLUE MARLIN GEAR = TROLLING LINE			
0 TO 2 MILES	14,378	11,638	\$6,015
2 TO 20 MILES	382,176	330,882	\$159,730
NORTHWESTERN H.I.	173	173	\$96
BEYOND 20 MILES	9,060	6,565	\$3,022
SPECIES = BLUE MARLIN GEAR = OTHER			
2 TO 20 MILES	650	650	\$195
SPECIES = BROADBILL GEAR = FLAGLINE			
2 TO 20 MILES	489	489	\$1,028
BEYOND 20 MILES	206	206	\$210

Table 2.--Continued.

REGION	LBCAUGHT	LBSOLD	REVENUE
SPECIES = BROADBILL GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	445	445	\$632
2 TO 20 MILES	29,510	29,183	\$39,393
BEYOND 20 MILES	852	852	\$1,091
SPECIES = BROADBILL GEAR = TROLLING LINE			
0 TO 2 MILES	158	158	\$237
2 TO 20 MILES	874	874	\$982
SPECIES = BROADBILL GEAR = OTHER			
2 TO 20 MILES	490	490	\$515
SPECIES = SAILFISH GEAR = DEEP-SEA HANDLINE			
2 TO 20 MILES	273	233	\$126
BEYOND 20 MILES	174	174	\$290
SPECIES = SAILFISH GEAR = TROLLING LINE			
0 TO 2 MILES	64	--	--
2 TO 20 MILES	446	272	\$182
SPECIES = MAHIMAHI GEAR = FLAGLINE			
2 TO 20 MILES	7,562	7,562	\$15,981
BEYOND 20 MILES	1,290	1,222	\$2,546
SPECIES = MAHIMAHI GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	5,475	5,268	\$11,670
2 TO 20 MILES	33,537	32,508	\$71,323
BEYOND 20 MILES	1,854	1,719	\$4,167
OTHER	6	6	\$9
SPECIES = MAHIMAHI GEAR = INSHORE HANDLINE			
0 TO 2 MILES	92	81	\$205
2 TO 20 MILES	13	13	\$35
SPECIES = MAHIMAHI GEAR = TROLLING LINE			
0 TO 2 MILES	13,451	11,594	\$27,424
2 TO 20 MILES	164,732	141,667	\$303,092
NORTHWESTERN H.I.	352	352	\$808

Table 2.--Continued.

REGION	LBCAUGHT	LBSOLD	REVENUE
SPECIES = MAHIMAH I GEAR = TROLLING LINE			
BEYOND 20 MILES	1,676	1,018	\$2,349
SPECIES = MAHIMAH I GEAR = OTHER			
0 TO 2 MILES	66	66	\$100
2 TO 20 MILES	5,007	5,007	\$10,547
BEYOND 20 MILES	3,457	3,457	\$5,615
OTHER	20	20	\$59
SPECIES = ONO GEAR = FLAGLINE			
2 TO 20 MILES	2,014	2,014	\$3,295
BEYOND 20 MILES	581	581	\$1,307
SPECIES = ONO GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	5,035	5,010	\$9,239
2 TO 20 MILES	33,780	32,694	\$64,184
BEYOND 20 MILES	1,470	1,440	\$2,814
OTHER	58	58	\$97
SPECIES = ONO GEAR = INSHORE HANDLINE			
0 TO 2 MILES	48	44	\$37
SPECIES = ONO GEAR = TROLLING LINE			
0 TO 2 MILES	39,327	34,314	\$68,568
2 TO 20 MILES	178,897	157,802	\$293,694
NORTHWESTERN H.I.	3,713	3,713	\$7,245
BEYOND 20 MILES	960	530	\$927
OTHER	138	138	\$166
SPECIES = ONO GEAR = OTHER			
0 TO 2 MILES	107	107	\$161
2 TO 20 MILES	308	278	\$428
SPECIES = SHARK GEAR = FLAGLINE			
2 TO 20 MILES	101	101	\$35
BEYOND 20 MILES	169	169	\$67

Table 2.--Continued.

REGION	LBCAUGHT	LBSOLD	REVENUE
SPECIES = SHARK GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	4,666	--	--
2 TO 20 MILES	591	241	\$90
SPECIES = SHARK GEAR = INSHORE HANDLINE			
0 TO 2 MILES	1,333	13	\$6
SPECIES = SHARK GEAR = TROLLING LINE			
0 TO 2 MILES	763	113	\$39
2 TO 20 MILES	3,988	87	\$11
SPECIES = SHARK GEAR = OTHER			
0 TO 2 MILES	621	21	\$12
SPECIES = HAMMERHEAD SHARK GEAR = TROLLING LINE			
0 TO 2 MILES	95	--	--
2 TO 20 MILES	124	120	\$35
SPECIES = HAMMERHEAD SHARK GEAR = OTHER			
0 TO 2 MILES	225	225	\$96
SPECIES = SHORTBILL SPEARFISH GEAR = FLAGLINE			
2 TO 20 MILES	237	237	\$144
BEYOND 20 MILES	83	83	\$112
SPECIES = SHORTBILL SPEARFISH GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	108	108	\$134
2 TO 20 MILES	490	363	\$314
NORTHWESTERN H.I.	18	18	\$10
BEYOND 20 MILES	26	26	\$10
SPECIES = SHORTBILL SPEARFISH GEAR = INSHORE HANDLINE			
0 TO 2 MILES	6	6	\$8
SPECIES = SHORTBILL SPEARFISH GEAR = TROLLING LINE			
0 TO 2 MILES	271	201	\$186
2 TO 20 MILES	10,431	7,913	\$7,057
BEYOND 20 MILES	327	167	\$178

Table 2.--Continued.

REGION	LBCAUGHT	LBSOLD	REVENUE
SPECIES = SHORTBILL SPEARFISH GEAR = OTHER			
0 TO 2 MILES	1	1	\$1
SPECIES = BLACK MARLIN GEAR = DEEP-SEA HANDLINE			
2 TO 20 MILES	527	249	\$447
SPECIES = BLACK MARLIN GEAR = TROLLING LINE			
0 TO 2 MILES	455	455	\$291
2 TO 20 MILES	4,658	4,220	\$2,943
BEYOND 20 MILES	220	220	\$110
SPECIES = BLACK MARLIN GEAR = OTHER			
0 TO 2 MILES	10	4	\$2

II TABLE 2.--HDAR 1981 DATA BY SPECIES, GEAR, AND REGION.

REGION	LBCAUGHT	LBSOLD	REVENUE
SPECIES = STRIPED MARLIN GEAR = FLAGLINE			
2 TO 20 MILES	4,773	4,773	\$5,838
BEYOND 20 MILES	6,504	6,504	\$7,862
OTHER	382	382	\$534
SPECIES = STRIPED MARLIN GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	47	47	\$47
2 TO 20 MILES	588	585	\$665
NORTHWESTERN H.I.	38	38	\$22
SPECIES = STRIPED MARLIN GEAR = TROLLING LINE			
0 TO 2 MILES	454	404	\$786
2 TO 20 MILES	18,255	14,070	\$16,932
BEYOND 20 MILES	69	69	\$67
SPECIES = BLUE MARLIN GEAR = FLAGLINE			
2 TO 20 MILES	384	384	\$393
BEYOND 20 MILES	1,393	1,393	\$1,250
OTHER	278	278	\$250
SPECIES = BLUE MARLIN GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	546	430	\$561
2 TO 20 MILES	5,432	4,852	\$5,009
BEYOND 20 MILES	490	490	\$122
SPECIES = BLUE MARLIN GEAR = TROLLING LINE			
0 TO 2 MILES	2,278	1,798	\$1,292
2 TO 20 MILES	101,889	85,961	\$56,276
NORTHWESTERN H.I.	232	232	\$135
BEYOND 20 MILES	962	962	\$940
SPECIES = BROADBILL GEAR = FLAGLINE			
BEYOND 20 MILES	26	26	\$14
SPECIES = BROADBILL GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	14	14	\$10
2 TO 20 MILES	1,621	1,567	\$2,745

Table 2.--Continued.

REGION	LB CAUGHT	LB SOLD	REVENUE
SPECIES = SAILFISH GEAR = FLAGLINE			
BEYOND 20 MILES	103	103	\$85
SPECIES = SAILFISH GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	21	21	\$15
SPECIES = SAILFISH GEAR = TROLLING LINE			
2 TO 20 MILES	260	180	\$183
SPECIES = MAHIMAH I GEAR = FLAGLINE			
2 TO 20 MILES	2,514	2,514	\$6,027
BEYOND 20 MILES	589	544	\$1,308
SPECIES = MAHIMAH I GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	1,490	1,420	\$3,621
2 TO 20 MILES	13,287	13,026	\$32,248
NORTHWESTERN H. I.	31	31	\$57
BEYOND 20 MILES	435	335	\$619
OTHER	9	9	\$18
SPECIES = MAHIMAH I GEAR = TROLLING LINE			
0 TO 2 MILES	5,447	4,888	\$12,660
2 TO 20 MILES	64,521	54,781	\$129,142
NORTHWESTERN H. I.	104	104	\$442
BEYOND 20 MILES	1,253	1,213	\$3,192
OTHER	13	13	\$27
SPECIES = MAHIMAH I GEAR = OTHER			
0 TO 2 MILES	46	46	\$188
2 TO 20 MILES	2,797	2,797	\$4,046
BEYOND 20 MILES	317	317	\$984
SPECIES = ONO GEAR = FLAGLINE			
2 TO 20 MILES	329	329	\$817
BEYOND 20 MILES	168	168	\$414

Table 2.--Continued.

REGION	LBCAUGHT	LBSOLD	REVENUE
SPECIES = ONO GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	902	843	\$1,718
2 TO 20 MILES	12,705	12,424	\$28,321
BEYOND 20 MILES	93	93	\$180
SPECIES = ONO GEAR = INSHORE HANDLINE			
0 TO 2 MILES	22	--	--
SPECIES = ONO GEAR = TROLLING LINE			
0 TO 2 MILES	7,420	6,599	\$16,916
2 TO 20 MILES	42,248	38,186	\$88,595
NORTHWESTERN H.I.	2,537	2,537	\$5,023
BEYOND 20 MILES	484	471	\$1,439
OTHER	213	213	\$606
SPECIES = ONO GEAR = OTHER			
2 TO 20 MILES	13	13	\$19
SPECIES = SHARK GEAR = DEEP-SEA HANDLINE			
0 TO 2 MILES	281	--	--
2 TO 20 MILES	3,610	650	\$306
SPECIES = SHARK GEAR = INSHORE HANDLINE			
0 TO 2 MILES	793	--	--
SPECIES = SHARK GEAR = TROLLING LINE			
2 TO 20 MILES	550	--	--
SPECIES = SHARK GEAR = OTHER			
0 TO 2 MILES	1	1	\$1
SPECIES = HAMMERHEAD SHARK GEAR = TROLLING LINE			
2 TO 20 MILES	200	--	--
SPECIES = SHORTBILL SPEARFISH GEAR = FLAGLINE			
2 TO 20 MILES	67	67	\$50

Table 2.--Continued.

REGION	LBCAUGHT	LBSOLD	REVENUE
SPECIES = SHORTBILL SPEARFISH GEAR = DEEP-SEA HANDLINE			
2 TO 20 MILES	556	505	\$399
NORTHWESTERN H.I.	46	46	\$27
SPECIES = SHORTBILL SPEARFISH GEAR = INSHORE HANDLINE			
0 TO 2 MILES	54	54	\$24
SPECIES = SHORTBILL SPEARFISH GEAR = TROLLING LINE			
2 TO 20 MILES	5,196	3,550	\$4,031
BEYOND 20 MILES	81	51	\$53
SPECIES = BLACK MARLIN GEAR = TROLLING LINE			
0 TO 2 MILES	320	320	\$192
2 TO 20 MILES	3,537	3,171	\$1,883

II TABLE 3.--HDAR 1976 DATA BY SPECIES, REGION, AND GEAR.

GEAR	LBCAUGHT	LBSOLD	REVENUE
SPECIES = STRIPED MARLIN REGION = 0 TO 2 MILES			
FLAGLINE	708	708	\$820
DEEP-SEA HANDLINE	1,002	1,002	\$181
INSHORE HANDLINE	79	79	\$98
TROLLING LINE	5,145	3,115	\$1,017
SPECIES = STRIPED MARLIN REGION = 2 TO 20 MILES			
FLAGLINE	67,317	67,317	\$71,689
DEEP-SEA HANDLINE	10,895	9,942	\$3,841
TROLLING LINE	115,602	68,775	\$26,081
SPECIES = STRIPED MARLIN REGION = BEYOND 20 MILES			
FLAGLINE	6,239	6,239	\$8,609
DEEP-SEA HANDLINE	442	442	\$398
TROLLING LINE	1,485	1,485	\$1,150
SPECIES = STRIPED MARLIN REGION = OTHER			
TROLLING LINE	70	50	\$75
SPECIES = BLUE MARLIN REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	490	189	\$38
TROLLING LINE	4,543	3,835	\$1,267
SPECIES = BLUE MARLIN REGION = 2 TO 20 MILES			
FLAGLINE	14,553	14,553	\$10,739
DEEP-SEA HANDLINE	10,748	10,564	\$3,708
TROLLING LINE	154,514	97,079	\$33,522
SPECIES = BLUE MARLIN REGION = BEYOND 20 MILES			
FLAGLINE	2,198	2,198	\$1,351
TROLLING LINE	4,174	3,670	\$1,681
SPECIES = BROADBILL REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	103	103	\$52
SPECIES = BROADBILL REGION = 2 TO 20 MILES			
FLAGLINE	429	429	\$174
DEEP-SEA HANDLINE	2,356	2,074	\$1,337
TROLLING LINE	543	543	\$451

Table 3.--Continued.

GEAR	LB CAUGHT	LB SOLD	REVENUE
SPECIES = BROADBILL REGION = BEYOND 20 MILES			
DEEP-SEA HANDLINE	90	90	\$45
SPECIES = SAILFISH REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	46	46	\$14
TROLLING LINE	98	98	\$23
SPECIES = SAILFISH REGION = 2 TO 20 MILES			
FLAGLINE	529	529	\$253
DEEP-SEA HANDLINE	235	159	\$41
TROLLING LINE	1,204	613	\$251
SPECIES = SAILFISH REGION = BEYOND 20 MILES			
FLAGLINE	55	55	\$17
DEEP-SEA HANDLINE	176	176	\$95
SPECIES = MAHIMAH I REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	992	820	\$1,112
INSHORE HANDLINE	262	216	\$316
TROLLING LINE	4,644	3,178	\$4,595
OTHER	305	303	\$377
SPECIES = MAHIMAH I REGION = 2 TO 20 MILES			
FLAGLINE	15,087	15,087	\$27,553
DEEP-SEA HANDLINE	22,526	21,703	\$32,091
INSHORE HANDLINE	107	107	\$137
TROLLING LINE	82,987	58,340	\$92,483
OTHER	5,958	5,906	\$10,205
SPECIES = MAHIMAH I REGION = NORTHWESTERN H.I.			
DEEP-SEA HANDLINE	67	67	\$93
SPECIES = MAHIMAH I REGION = BEYOND 20 MILES			
FLAGLINE	1,374	1,374	\$2,450
DEEP-SEA HANDLINE	1,215	1,215	\$1,741
TROLLING LINE	2,332	1,818	\$3,579
OTHER	1,132	1,132	\$1,538

Table 3.--Continued.

GEAR	LBCAUGHT	LBSOLD	REVENUE
SPECIES = MAHIMAH I REGION = OTHER			
TROLLING LINE	102	87	\$131
SPECIES = ONO REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	2,418	2,398	\$2,146
INSHORE HANDLINE	547	547	\$458
TROLLING LINE	19,220	15,321	\$16,565
SPECIES = ONO REGION = 2 TO 20 MILES			
FLAGLINE	5,843	5,843	\$5,120
DEEP-SEA HANDLINE	32,202	28,908	\$24,969
INSHORE HANDLINE	170	170	\$164
TROLLING LINE	98,587	71,550	\$69,846
OTHER	277	277	\$250
SPECIES = ONO REGION = NORTHWESTERN H.I.			
DEEP-SEA HANDLINE	8,200	8,200	\$6,082
SPECIES = ONO REGION = BEYOND 20 MILES			
FLAGLINE	1,693	1,693	\$1,290
DEEP-SEA HANDLINE	204	174	\$138
TROLLING LINE	265	260	\$228
SPECIES = ONO REGION = OTHER			
TROLLING LINE	56	56	\$39
SPECIES = SHARK REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	10	0	\$0
OTHER	760	0	\$0
SPECIES = SHARK REGION = 2 TO 20 MILES			
DEEP-SEA HANDLINE	339	0	\$0
TROLLING LINE	260	0	\$0
OTHER	9	9	\$7
SPECIES = HAMMERHEAD SHARK REGION = 0 TO 2 MILES			
INSHORE HANDLINE	27	0	\$0
OTHER	135	0	\$0

Table 3.--Continued.

GEAR	LBCAUGHT	LBSOLD	REVENUE
SPECIES = SHORTBILL SPEARFISH REGION = 0 TO 2 MILES			
TROLLING LINE	414	65	\$89
SPECIES = SHORTBILL SPEARFISH REGION = 2 TO 20 MILES			
FLAGLINE	5,692	5,692	\$4,067
DEEP-SEA HANDLINE	395	395	\$189
TROLLING LINE	5,141	2,985	\$1,319
SPECIES = SHORTBILL SPEARFISH REGION = BEYOND 20 MILES			
FLAGLINE	1,345	1,345	\$1,026
DEEP-SEA HANDLINE	654	654	\$664
TROLLING LINE	81	77	\$19
SPECIES = BLACK MARLIN REGION = 2 TO 20 MILES			
FLAGLINE	419	419	\$443
DEEP-SEA HANDLINE	1,003	1,003	\$163
TROLLING LINE	5,054	3,645	\$1,330
SPECIES = BLACK MARLIN REGION = BEYOND 20 MILES			
TROLLING LINE	397	397	\$297

II TABLE 3.--HDAR 1977 DATA BY SPECIES, REGION, AND GEAR.

GEAR	LBCAUGHT	LBSOLD	REVENUE
SPECIES = SWORDFISH REGION = 2 TO 20 MILES			
TROLLING LINE	138	138	\$62
SPECIES = STRIPED MARLIN REGION = 0 TO 2 MILES			
TROLLING LINE	622	566	\$290
SPECIES = STRIPED MARLIN REGION = 2 TO 20 MILES			
FLAGLINE	64,772	64,772	\$79,657
DEEP-SEA HANDLINE	1,217	1,174	\$1,095
INSHORE HANDLINE	100	100	\$100
TROLLING LINE	18,923	10,922	\$9,086
SPECIES = STRIPED MARLIN REGION = BEYOND 20 MILES			
FLAGLINE	5,161	5,161	\$6,603
DEEP-SEA HANDLINE	110	110	\$105
TROLLING LINE	381	331	\$270
SPECIES = STRIPED MARLIN REGION = OTHER			
TROLLING LINE	50	0	\$0
SPECIES = BLUE MARLIN REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	895	534	\$333
TROLLING LINE	6,810	3,641	\$1,252
SPECIES = BLUE MARLIN REGION = 2 TO 20 MILES			
FLAGLINE	22,523	22,523	\$17,834
DEEP-SEA HANDLINE	15,858	13,196	\$5,776
TROLLING LINE	314,008	228,526	\$81,502
SPECIES = BLUE MARLIN REGION = BEYOND 20 MILES			
FLAGLINE	2,103	2,103	\$1,636
TROLLING LINE	4,023	2,962	\$1,183
SPECIES = BROADBILL REGION = 2 TO 20 MILES			
FLAGLINE	35,362	35,362	\$61,388
DEEP-SEA HANDLINE	3,756	3,756	\$3,191
TROLLING LINE	290	290	\$323

Table 3.--Continued.

GEAR	LB CAUGHT	LBS SOLD	REVENUE
SPECIES = BROADBILL REGION = BEYOND 20 MILES			
FLAGLINE	1,603	1,603	\$2,830
DEEP-SEA HANDLINE	224	224	\$198
SPECIES = SAILFISH REGION = 0 TO 2 MILES			
TROLLING LINE	135	135	\$119
SPECIES = SAILFISH REGION = 2 TO 20 MILES			
FLAGLINE	620	620	\$626
DEEP-SEA HANDLINE	107	39	\$23
TROLLING LINE	376	223	\$133
OTHER	22	22	\$13
SPECIES = SAILFISH REGION = BEYOND 20 MILES			
FLAGLINE	114	114	\$69
DEEP-SEA HANDLINE	26	26	\$17
TROLLING LINE	7	0	\$0
SPECIES = MAHIMAHI REGION = 0 TO 2 MILES			
FLAGLINE	55	55	\$83
DEEP-SEA HANDLINE	1,817	1,757	\$2,607
INSHORE HANDLINE	226	211	\$369
TROLLING LINE	5,955	4,807	\$6,714
OTHER	293	293	\$480
SPECIES = MAHIMAHI REGION = 2 TO 20 MILES			
FLAGLINE	13,805	13,805	\$27,620
DEEP-SEA HANDLINE	15,462	14,563	\$22,993
INSHORE HANDLINE	228	228	\$299
TROLLING LINE	100,538	77,578	\$141,838
OTHER	5,696	5,671	\$10,564
SPECIES = MAHIMAHI REGION = NORTHWESTERN H.I.			
TROLLING LINE	20	20	\$30
SPECIES = MAHIMAHI REGION = BEYOND 20 MILES			
FLAGLINE	1,007	1,007	\$1,761
DEEP-SEA HANDLINE	971	971	\$1,598
TROLLING LINE	1,482	1,311	\$2,299
OTHER	2,765	2,765	\$4,543

Table 3.--Continued.

GEAR	LBCAUGHT	LBSOLD	REVENUE
SPECIES = ONO REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	3,202	3,202	\$2,810
INSHORE HANDLINE	224	224	\$196
TROLLING LINE	26,730	23,109	\$26,810
OTHER	182	182	\$182
SPECIES = ONO REGION = 2 TO 20 MILES			
FLAGLINE	11,316	11,316	\$10,204
DEEP-SEA HANDLINE	24,237	23,402	\$23,408
INSHORE HANDLINE	805	750	\$750
TROLLING LINE	151,358	122,348	\$134,072
OTHER	380	360	\$372
SPECIES = ONO REGION = NORTHWESTERN H.I.			
DEEP-SEA HANDLINE	612	612	\$817
TROLLING LINE	1,055	1,055	\$858
SPECIES = ONO REGION = BEYOND 20 MILES			
FLAGLINE	868	868	\$963
DEEP-SEA HANDLINE	1,127	1,127	\$1,082
TROLLING LINE	1,070	668	\$1,011
OTHER	8	8	\$6
SPECIES = ONO REGION = OTHER			
TROLLING LINE	254	254	\$270
SPECIES = SHARK REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	548	134	\$18
INSHORE HANDLINE	450	0	\$0
TROLLING LINE	100	0	\$0
OTHER	543	3	\$0
SPECIES = SHARK REGION = 2 TO 20 MILES			
DEEP-SEA HANDLINE	695	416	\$112
TROLLING LINE	461	161	\$32
OTHER	354	154	\$45
SPECIES = SHARK REGION = BEYOND 20 MILES			
INSHORE HANDLINE	230	0	\$0

Table 3.--Continued.

GEAR	LBCAUGHT	LBSOLD	REVENUE
SPECIES = HAMMERHEAD SHARK REGION = 0 TO 2 MILES			
OTHER	40	0	\$0
SPECIES = SHORTBILL SPEARFISH REGION = 0 TO 2 MILES			
TROLLING LINE	74	74	\$47
OTHER	81	81	\$66
SPECIES = SHORTBILL SPEARFISH REGION = 2 TO 20 MILES			
FLAGLINE	6,133	6,133	\$4,419
DEEP-SEA HANDLINE	473	396	\$163
TROLLING LINE	5,676	2,886	\$1,449
SPECIES = SHORTBILL SPEARFISH REGION = BEYOND 20 MILES			
FLAGLINE	297	297	\$175
TROLLING LINE	29	29	\$49
SPECIES = BLACK MARLIN REGION = 2 TO 20 MILES			
FLAGLINE	258	258	\$401
DEEP-SEA HANDLINE	730	557	\$332
TROLLING LINE	5,606	3,195	\$1,132
SPECIES = BLACK MARLIN REGION = BEYOND 20 MILES			
FLAGLINE	205	205	\$174
TROLLING LINE	1,278	1,278	\$516

II TABLE 3.--HDAR 1978 DATA BY SPECIES, REGION, AND GEAR.

GEAR	LB CAUGHT	LBS SOLD	REVENUE
SPECIES = STRIPED MARLIN REGION = 0 TO 2 MILES			
INSHORE HANDLINE	136	136	\$54
TROLLING LINE	497	337	\$279
SPECIES = STRIPED MARLIN REGION = 2 TO 20 MILES			
FLAGLINE	87,889	87,889	\$124,052
DEEP-SEA HANDLINE	2,613	2,287	\$2,280
TROLLING LINE	36,752	26,545	\$25,476
SPECIES = STRIPED MARLIN REGION = BEYOND 20 MILES			
FLAGLINE	17,382	17,382	\$21,314
DEEP-SEA HANDLINE	585	545	\$409
TROLLING LINE	1,167	1,045	\$789
SPECIES = BLUE MARLIN REGION = 0 TO 2 MILES			
INSHORE HANDLINE	1,114	1,114	\$465
TROLLING LINE	6,863	3,822	\$1,716
SPECIES = BLUE MARLIN REGION = 2 TO 20 MILES			
FLAGLINE	34,622	34,622	\$32,643
DEEP-SEA HANDLINE	11,156	10,809	\$4,945
TROLLING LINE	464,326	360,320	\$157,749
SPECIES = BLUE MARLIN REGION = BEYOND 20 MILES			
FLAGLINE	5,458	5,458	\$4,536
DEEP-SEA HANDLINE	988	988	\$280
TROLLING LINE	12,791	11,656	\$3,761
SPECIES = BROADBILL REGION = 0 TO 2 MILES			
INSHORE HANDLINE	47	47	\$47
SPECIES = BROADBILL REGION = 2 TO 20 MILES			
FLAGLINE	11,952	11,282	\$17,181
DEEP-SEA HANDLINE	8,916	8,916	\$10,235
TROLLING LINE	558	558	\$736

Table 3.--Continued.

GEAR	LBCAUGHT	LBSOLD	REVENUE
SPECIES = BROADBILL REGION = BEYOND 20 MILES			
FLAGLINE	8,530	8,530	\$12,683
DEEP-SEA HANDLINE	140	140	\$105
SPECIES = SAILFISH REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	70	70	\$70
SPECIES = SAILFISH REGION = 2 TO 20 MILES			
FLAGLINE	49	49	\$37
DEEP-SEA HANDLINE	43	43	\$15
TROLLING LINE	535	210	\$101
SPECIES = MAHIMAHI REGION = 0 TO 2 MILES			
FLAGLINE	881	881	\$1,469
DEEP-SEA HANDLINE	307	307	\$486
INSHORE HANDLINE	850	787	\$1,424
TROLLING LINE	3,898	2,984	\$4,908
OTHER	4	4	\$6
SPECIES = MAHIMAHI REGION = 2 TO 20 MILES			
FLAGLINE	7,449	7,449	\$17,480
DEEP-SEA HANDLINE	12,654	12,111	\$22,111
INSHORE HANDLINE	19	19	\$29
TROLLING LINE	91,774	72,874	\$144,685
OTHER	8,732	8,732	\$16,600
SPECIES = MAHIMAHI REGION = NORTHWESTERN H.I.			
DEEP-SEA HANDLINE	118	118	\$192
SPECIES = MAHIMAHI REGION = BEYOND 20 MILES			
FLAGLINE	2,092	2,092	\$4,336
DEEP-SEA HANDLINE	512	512	\$843
TROLLING LINE	772	548	\$1,274
OTHER	514	514	\$1,201
SPECIES = MAHIMAHI REGION = OTHER			
TROLLING LINE	172	172	\$371
OTHER	14	14	\$38

Table 3.--Continued.

GEAR	LBCAUGHT	LBSOLD	REVENUE
SPECIES = ONO REGION = 0 TO 2 MILES			
FLAGLINE	534	534	\$775
DEEP-SEA HANDLINE	411	386	\$490
INSHORE HANDLINE	1,943	1,888	\$2,529
TROLLING LINE	13,951	11,303	\$16,131
OTHER	43	0	\$0
SPECIES = ONO REGION = 2 TO 20 MILES			
FLAGLINE	7,722	7,722	\$9,701
DEEP-SEA HANDLINE	21,887	21,438	\$27,124
INSHORE HANDLINE	68	34	\$53
TROLLING LINE	140,566	116,466	\$156,433
OTHER	87	55	\$55
SPECIES = ONO REGION = NORTHWESTERN H.I.			
DEEP-SEA HANDLINE	1,996	1,996	\$4,839
SPECIES = ONO REGION = BEYOND 20 MILES			
FLAGLINE	1,917	1,917	\$2,677
DEEP-SEA HANDLINE	314	304	\$354
TROLLING LINE	1,626	1,395	\$1,945
SPECIES = ONO REGION = OTHER			
TROLLING LINE	1,913	1,913	\$2,157
SPECIES = SHARK REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	300	72	\$25
INSHORE HANDLINE	531	166	\$72
TROLLING LINE	1,525	60	\$35
OTHER	243	43	\$2
SPECIES = SHARK REGION = 2 TO 20 MILES			
FLAGLINE	11,085	1,335	\$453
DEEP-SEA HANDLINE	3,740	1,282	\$472
TROLLING LINE	3,164	964	\$393
SPECIES = SHARK REGION = BEYOND 20 MILES			
DEEP-SEA HANDLINE	82	82	\$44

Table 3.--Continued.

GEAR	LBCAUGHT	LBSOLD	REVENUE
SPECIES = HAMMERHEAD SHARK REGION = 0 TO 2 MILES			
OTHER	1,527	--	--
SPECIES = SHORTBILL SPEARFISH REGION = 2 TO 20 MILES			
FLAGLINE	9,719	9,719	\$11,023
DEEP-SEA HANDLINE	577	577	\$676
TROLLING LINE	12,637	7,744	\$6,109
SPECIES = SHORTBILL SPEARFISH REGION = BEYOND 20 MILES			
FLAGLINE	1,449	1,449	\$1,616
TROLLING LINE	337	307	\$282
SPECIES = BLACK MARLIN REGION = 2 TO 20 MILES			
TROLLING LINE	1,368	424	\$434

II TABLE 3.--HDAR 1979 DATA BY SPECIES, REGION, AND GEAR.

GEAR	LB CAUGHT	LBSOLD	REVENUE
SPECIES = SWORDFISH REGION = 2 TO 20 MILES			
DEEP-SEA HANDLINE	2	--	--
SPECIES = STRIPED MARLIN REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	286	216	\$115
TROLLING LINE	989	837	\$992
SPECIES = STRIPED MARLIN REGION = 2 TO 20 MILES			
FLAGLINE	66,510	66,510	\$94,880
DEEP-SEA HANDLINE	4,474	4,364	\$5,493
TROLLING LINE	32,110	24,362	\$25,454
OTHER	330	75	\$172
SPECIES = STRIPED MARLIN REGION = BEYOND 20 MILES			
FLAGLINE	4,954	4,954	\$8,903
DEEP-SEA HANDLINE	644	644	\$781
TROLLING LINE	875	700	\$445
OTHER	232	232	\$153
SPECIES = STRIPED MARLIN REGION = OTHER			
FLAGLINE	397	397	\$288
SPECIES = BLUE MARLIN REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	705	705	\$436
TROLLING LINE	18,386	14,922	\$6,171
SPECIES = BLUE MARLIN REGION = 2 TO 20 MILES			
FLAGLINE	13,747	13,747	\$14,536
DEEP-SEA HANDLINE	12,508	12,211	\$8,980
TROLLING LINE	374,958	294,078	\$138,877
OTHER	659	659	\$98
SPECIES = BLUE MARLIN REGION = BEYOND 20 MILES			
FLAGLINE	1,481	1,481	\$1,507
DEEP-SEA HANDLINE	1,569	1,464	\$1,267
TROLLING LINE	13,042	11,255	\$4,082
OTHER	234	234	\$70

Table 3.--Continued.

GEAR	LBCAUGHT	LBSOLD	REVENUE
SPECIES = BLUE MARLIN REGION = OTHER			
TROLLING LINE	180	--	--
SPECIES = BROADBILL REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	827	812	\$1,152
SPECIES = BROADBILL REGION = 2 TO 20 MILES			
FLAGLINE	14,278	14,278	\$23,566
DEEP-SEA HANDLINE	12,201	12,201	\$16,812
TROLLING LINE	350	121	\$96
SPECIES = BROADBILL REGION = NORTHWESTERN H.I.			
DEEP-SEA HANDLINE	141	141	\$176
SPECIES = BROADBILL REGION = BEYOND 20 MILES			
FLAGLINE	220	220	\$330
DEEP-SEA HANDLINE	621	621	\$812
SPECIES = BROADBILL REGION = OTHER			
FLAGLINE	300	300	\$498
SPECIES = SAILFISH REGION = 0 TO 2 MILES			
TROLLING LINE	152	77	\$56
SPECIES = SAILFISH REGION = 2 TO 20 MILES			
FLAGLINE	677	677	\$597
DEEP-SEA HANDLINE	99	99	\$82
TROLLING LINE	1,203	604	\$351
SPECIES = SAILFISH REGION = BEYOND 20 MILES			
FLAGLINE	73	73	\$42
DEEP-SEA HANDLINE	77	77	\$86

Table 3.--Continued.

GEAR	LB CAUGHT	LBS SOLD	REVENUE
SPECIES = MAHIMAH I REGION = 0 TO 2 MILES			
FLAGLINE	510	510	\$920
DEEP-SEA HANDLINE	2,314	2,061	\$3,261
INSHORE HANDLINE	87	80	\$127
TROLLING LINE	6,399	4,960	\$9,263
OTHER	98	98	\$203
SPECIES = MAHIMAH I REGION = 2 TO 20 MILES			
FLAGLINE	6,508	6,508	\$13,655
DEEP-SEA HANDLINE	19,285	18,307	\$34,539
INSHORE HANDLINE	14	--	--
TROLLING LINE	124,447	104,039	\$206,138
OTHER	6,492	6,447	\$12,328
SPECIES = MAHIMAH I REGION = NORTHWESTERN H.I.			
TROLLING LINE	30	30	\$30
SPECIES = MAHIMAH I REGION = BEYOND 20 MILES			
FLAGLINE	553	553	\$1,054
DEEP-SEA HANDLINE	2,040	2,040	\$3,891
TROLLING LINE	1,395	997	\$1,834
OTHER	3,754	3,754	\$5,205
SPECIES = MAHIMAH I REGION = OTHER			
FLAGLINE	274	250	\$620
TROLLING LINE	311	311	\$647
OTHER	37	37	\$34
SPECIES = ONO REGION = 0 TO 2 MILES			
FLAGLINE	29	29	\$59
DEEP-SEA HANDLINE	4,135	3,968	\$6,140
INSHORE HANDLINE	282	232	\$361
TROLLING LINE	27,982	23,658	\$43,499
OTHER	28	28	\$65
SPECIES = ONO REGION = 2 TO 20 MILES			
FLAGLINE	2,741	2,741	\$5,247
DEEP-SEA HANDLINE	16,826	16,148	\$27,170
TROLLING LINE	136,589	114,537	\$199,021
OTHER	52	27	\$71

Table 3.--Continued.

GEAR	LBCAUGHT	LBSOLD	REVENUE
SPECIES = ONO REGION = 2 TO 20 MILES			
DEEP-SEA HANDLINE	96	96	\$133
TROLLING LINE	7,094	7,094	\$16,001
SPECIES = ONO REGION = BEYOND 20 MILES			
FLAGLINE	445	445	\$1,206
DEEP-SEA HANDLINE	833	759	\$1,921
TROLLING LINE	1,285	822	\$1,256
OTHER	42	42	\$73
SPECIES = ONO REGION = OTHER			
FLAGLINE	297	297	\$565
DEEP-SEA HANDLINE	5	--	--
TROLLING LINE	1,218	1,218	\$3,025
SPECIES = SHARK REGION = 0 TO 2 MILES			
INSHORE HANDLINE	58	--	--
TROLLING LINE	66	66	\$6
OTHER	1,026	29	\$48
SPECIES = SHARK REGION = 2 TO 20 MILES			
FLAGLINE	871	871	\$397
DEEP-SEA HANDLINE	190	--	--
TROLLING LINE	1,549	238	\$37
OTHER	135	135	\$41
SPECIES = SHARK REGION = BEYOND 20 MILES			
FLAGLINE	534	534	\$188
SPECIES = HAMMERHEAD SHARK REGION = 0 TO 2 MILES			
OTHER	1,880	--	--
SPECIES = HAMMERHEAD SHARK REGION = 2 TO 20 MILES			
TROLLING LINE	150	--	--
SPECIES = SHORTBILL SPEARFISH REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	45	45	\$56
TROLLING LINE	391	391	\$298
OTHER	729	679	\$669

Table 3.--Continued.

GEAR	LB CAUGHT	LB SOLD	REVENUE
SPECIES = SHORTBILL SPEARFISH REGION = 2 TO 20 MILES			
FLAGLINE	3,747	3,747	\$4,422
DEEP-SEA HANDLINE	410	390	\$329
TROLLING LINE	11,013	7,425	\$8,383
SPECIES = SHORTBILL SPEARFISH REGION = BEYOND 20 MILES			
FLAGLINE	622	622	\$823
TROLLING LINE	229	110	\$129
OTHER	30	--	--
SPECIES = SHORTBILL SPEARFISH REGION = OTHER			
TROLLING LINE	38	38	\$19
SPECIES = BLACK MARLIN REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	202	202	\$101
SPECIES = BLACK MARLIN REGION = 2 TO 20 MILES			
FLAGLINE	100	100	\$98
DEEP-SEA HANDLINE	1,633	1,285	\$1,322
TROLLING LINE	8,618	6,111	\$2,860
SPECIES = BLACK MARLIN REGION = BEYOND 20 MILES			
TROLLING LINE	443	318	\$151
SPECIES = BLACK MARLIN REGION = OTHER			
FLAGLINE	144	144	\$184

II TABLE 3.--HDAR 1980 DATA BY SPECIES, REGION, AND GEAR.

GEAR	LBCAUGHT	LBSOLD	REVENUE
SPECIES = STRIPED MARLIN REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	449	449	\$337
TROLLING LINE	1,455	1,306	\$1,742
SPECIES = STRIPED MARLIN REGION = 2 TO 20 MILES			
FLAGLINE	19,875	19,875	\$22,815
DEEP-SEA HANDLINE	2,466	2,367	\$3,085
TROLLING LINE	36,229	28,261	\$33,679
SPECIES = STRIPED MARLIN REGION = BEYOND 20 MILES			
FLAGLINE	4,539	4,539	\$5,325
DEEP-SEA HANDLINE	1,390	1,390	\$2,596
TROLLING LINE	486	446	\$496
SPECIES = STRIPED MARLIN REGION = OTHER			
TROLLING LINE	77	77	\$98
SPECIES = BLUE MARLIN REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	4,634	3,910	\$1,755
TROLLING LINE	14,378	11,638	\$6,015
SPECIES = BLUE MARLIN REGION = 2 TO 20 MILES			
FLAGLINE	6,870	6,870	\$5,920
DEEP-SEA HANDLINE	20,565	18,974	\$10,971
TROLLING LINE	382,176	330,882	\$159,730
OTHER	650	650	\$195
SPECIES = BLUE MARLIN REGION = NORTHWESTERN H.I.			
TROLLING LINE	173	173	\$96
SPECIES = BLUE MARLIN REGION = BEYOND 20 MILES			
FLAGLINE	1,834	1,834	\$1,760
DEEP-SEA HANDLINE	1,190	1,190	\$1,142
TROLLING LINE	9,060	6,565	\$3,022
SPECIES = BROADBILL REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	445	445	\$632
TROLLING LINE	158	158	\$237

Table 3.--Continued.

GEAR	LBCAUGHT	LBSOLD	REVENUE
SPECIES = BROADBILL REGION = 2 TO 20 MILES			
FLAGLINE	489	489	\$1,028
DEEP-SEA HANDLINE	29,510	29,183	\$39,393
TROLLING LINE	874	874	\$982
OTHER	490	490	\$515
SPECIES = BROADBILL REGION = BEYOND 20 MILES			
FLAGLINE	206	206	\$210
DEEP-SEA HANDLINE	852	852	\$1,091
SPECIES = SAILFISH REGION = 0 TO 2 MILES			
TROLLING LINE	64	--	--
SPECIES = SAILFISH REGION = 2 TO 20 MILES			
DEEP-SEA HANDLINE	273	233	\$126
TROLLING LINE	446	272	\$182
SPECIES = SAILFISH REGION = BEYOND 20 MILES			
DEEP-SEA HANDLINE	174	174	\$290
SPECIES = MAHIMAH I REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	5,475	5,268	\$11,670
INSHORE HANDLINE	92	81	\$205
TROLLING LINE	13,451	11,594	\$27,424
OTHER	66	66	\$100
SPECIES = MAHIMAH I REGION = 2 TO 20 MILES			
FLAGLINE	7,562	7,562	\$15,981
DEEP-SEA HANDLINE	33,537	32,508	\$71,323
INSHORE HANDLINE	13	13	\$35
TROLLING LINE	164,732	41,667	\$303,092
OTHER	5,007	5,007	\$10,547
SPECIES = MAHIMAH I REGION = NORTHWESTERN H.I.			
TROLLING LINE	352	352	\$808

Table 3.--Continued.

GEAR	LBCAUGHT	LBSOLD	REVENUE
SPECIES = MAHIMAHI REGION = BEYOND 20 MILES			
FLAGLINE	1,290	1,222	\$2,546
DEEP-SEA HANDLINE	1,854	1,719	\$4,167
TROLLING LINE	1,676	1,018	\$2,349
OTHER	3,457	3,457	\$5,615
SPECIES = MAHIMAHI REGION = OTHER			
DEEP-SEA HANDLINE	6	6	\$9
TROLLING LINE	70	57	\$89
OTHER	20	20	\$59
SPECIES = ONO REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	5,035	5,010	\$9,239
INSHORE HANDLINE	48	44	\$37
TROLLING LINE	39,327	34,314	\$68,568
OTHER	107	107	\$161
SPECIES = ONO REGION = 2 TO 20 MILES			
FLAGLINE	2,014	2,014	\$3,295
DEEP-SEA HANDLINE	33,780	32,694	\$64,184
TROLLING LINE	178,897	157,802	\$293,694
OTHER	308	278	\$428
SPECIES = ONO REGION = NORTHWESTERN H.I.			
TROLLING LINE	3,713	3,713	\$7,245
SPECIES = ONO REGION = BEYOND 20 MILES			
FLAGLINE	581	581	\$1,307
DEEP-SEA HANDLINE	1,470	1,440	\$2,814
TROLLING LINE	960	530	\$927
SPECIES = ONO REGION = OTHER			
DEEP-SEA HANDLINE	58	58	\$97
TROLLING LINE	138	138	\$166
SPECIES = SHARK REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	4,666	--	--
INSHORE HANDLINE	1,333	13	\$6
TROLLING LINE	763	113	\$39
OTHER	621	21	\$12

Table 3.--Continued.

GEAR	LB CAUGHT	LB SOLD	REVENUE
SPECIES = SHARK REGION = 2 TO 20 MILES			
FLAGLINE	101	101	\$35
DEEP-SEA HANDLINE	591	241	\$90
TROLLING LINE	3,988	87	\$11
SPECIES = SHARK REGION = BEYOND 20 MILES			
FLAGLINE	169	169	\$67
SPECIES = HAMMERHEAD SHARK REGION = 0 TO 2 MILES			
TROLLING LINE	95	--	--
OTHER	225	225	\$96
SPECIES = HAMMERHEAD SHARK REGION = 2 TO 20 MILES			
TROLLING LINE	124	120	\$35
SPECIES = SHORTBILL SPEARFISH REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	108	108	\$134
INSHORE HANDLINE	6	6	\$8
TROLLING LINE	271	201	\$186
OTHER	1	1	\$1
SPECIES = SHORTBILL SPEARFISH REGION = 2 TO 20 MILES			
FLAGLINE	237	237	\$144
DEEP-SEA HANDLINE	490	363	\$314
TROLLING LINE	10,431	7,913	\$7,057
SPECIES = SHORTBILL SPEARFISH REGION = NORTHWESTERN H.I.			
DEEP-SEA HANDLINE	18	18	\$10
SPECIES = SHORTBILL SPEARFISH REGION = BEYOND 20 MILES			
FLAGLINE	83	83	\$112
DEEP-SEA HANDLINE	26	26	\$10
TROLLING LINE	327	167	\$178
SPECIES = BLACK MARLIN REGION = 0 TO 2 MILES			
TROLLING LINE	455	455	\$291
OTHER	10	4	\$2

Table 3.--Continued.

GEAR	LBCAUGHT	LBSOLD	REVENUE
SPECIES = BLACK MARLIN REGION = 2 TO 20 MILES			
DEEP-SEA HANDLINE	527	249	\$447
TROLLING LINE	4,658	4,220	\$2,943
SPECIES = BLACK MARLIN REGION = BEYOND 20 MILES			
TROLLING LINE	220	220	\$110

II TABLE 3.--HDAR 1981 DATA BY SPECIES, REGION, AND GEAR.

GEAR	LBCAUGHT	LBSOLD	REVENUE
SPECIES = STRIPED MARLIN REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	47	47	\$47
TROLLING LINE	454	404	\$786
SPECIES = STRIPED MARLIN REGION = 2 TO 20 MILES			
FLAGLINE	4,773	4,773	\$5,838
DEEP-SEA HANDLINE	588	585	\$665
TROLLING LINE	18,255	14,070	\$16,932
SPECIES = STRIPED MARLIN REGION = NORTHWESTERN H.I.			
DEEP-SEA HANDLINE	38	38	\$22
SPECIES = STRIPED MARLIN REGION = BEYOND 20 MILES			
FLAGLINE	6,504	6,504	\$7,862
TROLLING LINE	69	69	\$67
SPECIES = STRIPED MARLIN REGION = OTHER			
FLAGLINE	382	382	\$534
SPECIES = BLUE MARLIN REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	546	430	\$561
TROLLING LINE	2,278	1,798	\$1,292
SPECIES = BLUE MARLIN REGION = 2 TO 20 MILES			
FLAGLINE	384	384	\$393
DEEP-SEA HANDLINE	5,432	4,852	\$5,009
TROLLING LINE	101,889	85,961	\$56,276
SPECIES = BLUE MARLIN REGION = NORTHWESTERN H.I.			
TROLLING LINE	232	232	\$135
SPECIES = BLUE MARLIN REGION = BEYOND 20 MILES			
FLAGLINE	1,393	1,393	\$1,250
DEEP-SEA HANDLINE	490	490	\$122
TROLLING LINE	962	962	\$940

Table 3.--Continued.

GEAR	LB CAUGHT	LB SOLD	REVENUE
SPECIES = BLUE MARLIN REGION = OTHER			
FLAGLINE	278	278	\$250
SPECIES = BROADBILL REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	14	14	\$10
SPECIES = BROADBILL REGION = 2 TO 20 MILES			
DEEP-SEA HANDLINE	1,621	1,567	\$2,745
SPECIES = BROADBILL REGION = BEYOND 20 MILES			
FLAGLINE	26	26	\$14
SPECIES = SAILFISH REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	21	21	\$15
SPECIES = SAILFISH REGION = 2 TO 20 MILES			
TROLLING LINE	260	180	\$183
SPECIES = SAILFISH REGION = BEYOND 20 MILES			
FLAGLINE	103	103	\$85
SPECIES = MAHIMAH I REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	1,490	1,420	\$3,621
TROLLING LINE	5,447	4,888	\$12,660
OTHER	46	46	\$188
SPECIES = MAHIMAH I REGION = 2 TO 20 MILES			
FLAGLINE	2,514	2,514	\$6,027
DEEP-SEA HANDLINE	13,287	13,026	\$32,248
TROLLING LINE	64,521	54,781	\$129,142
OTHER	2,797	2,797	\$4,046
SPECIES = MAHIMAH I REGION = NORTHWESTERN H.I.			
DEEP-SEA HANDLINE	31	31	\$57
TROLLING LINE	104	104	\$442

Table 3.--Continued.

GEAR	LBCAUGHT	LBSOLD	REVENUE
SPECIES = MAHIMAHI REGION = BEYOND 20 MILES			
FLAGLINE	589	544	\$1,308
DEEP-SEA HANDLINE	435	335	\$619
TROLLING LINE	1,253	1,213	\$3,192
OTHER	317	317	\$984
SPECIES = MAHIMAHI REGION = OTHER			
DEEP-SEA HANDLINE	9	9	\$18
TROLLING LINE	13	13	\$27
SPECIES = ONO REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	902	843	\$1,718
INSHORE HANDLINE	22	--	--
TROLLING LINE	7,420	6,599	\$16,916
SPECIES = ONO REGION = 2 TO 20 MILES			
FLAGLINE	329	329	\$817
DEEP-SEA HANDLINE	12,705	12,424	\$28,321
TROLLING LINE	42,248	38,186	\$88,595
OTHER	13	13	\$19
SPECIES = ONO REGION = NORTHWESTERN H.I.			
TROLLING LINE	2,537	2,537	\$5,023
SPECIES = ONO REGION = BEYOND 20 MILES			
FLAGLINE	168	168	\$414
DEEP-SEA HANDLINE	93	93	\$180
TROLLING LINE	484	471	\$1,439
SPECIES = ONO REGION = OTHER			
TROLLING LINE	213	213	\$606
SPECIES = SHARK REGION = 0 TO 2 MILES			
DEEP-SEA HANDLINE	281	--	--
INSHORE HANDLINE	793	--	--
OTHER	1	1	\$1

Table 3.--Continued.

GEAR	LBCAUGHT	LBSOLD	REVENUE
SPECIES = SHARK REGION = 2 TO 20 MILES			
DEEP-SEA HANDLINE	3,610	650	\$306
TROLLING LINE	550	--	--
SPECIES = HAMMERHEAD SHARK REGION = 2 TO 20 MILES			
TROLLING LINE	200	--	--
SPECIES = SHORTBILL SPEARFISH REGION = 0 TO 2 MILES			
INSHORE HANDLINE	54	54	\$24
SPECIES = SHORTBILL SPEARFISH REGION = 2 TO 20 MILES			
FLAGLINE	67	67	\$50
DEEP-SEA HANDLINE	556	505	\$399
TROLLING LINE	5,196	3,550	\$4,031
SPECIES = SHORTBILL SPEARFISH REGION = NORTHWESTERN H.I			
DEEP-SEA HANDLINE	46	46	\$27
SPECIES = SHORTBILL SPEARFISH REGION = BEYOND 20 MILES			
TROLLING LINE	81	51	\$53
SPECIES = BLACK MARLIN REGION = 0 TO 2 MILES			
TROLLING LINE	320	320	\$192
SPECIES = BLACK MARLIN REGION = 2 TO 20 MILES			
TROLLING LINE	3,537	3,171	\$1,883

84-3

SOUTHWEST FISHERIES CENTER

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NATIONAL MARINE FISHERIES SERVICE

TECHNIQUES FOR ASSESSING THE IMPACT OF OCEAN THERMAL ENERGY CONVERSION (OTEC) OPERATIONS ON FISHERIES

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I. INTRODUCTION

The environmental effects of a commercial ocean thermal energy conversion (OTEC) facility, which may process roughly $13.8 \times 10^6 \text{ m}^3$ of water per day (for a 40 MW plant), will impact the marine ecosystem and possibly extend to the marine fisheries. The final environmental impact statement (EIS) prepared by the National Oceanic and Atmospheric Administration (NOAA) for commercial OTEC licensing indicated that the majority of the environmental effects center on the marine ecosystem because it is the source of evaporating and condensing waters and the recipient of the plant's effluent ([U.S.] NOAA 1981). The EIS further categorized these effects as being major (those potentially causing significant long-term environmental impact), minor (those causing insignificant long- or short-term environmental changes), and potential (short-term impacts occurring only during accidents). The major effects included attraction or avoidance of organisms to the structure, impingement on, and entrainment of, organisms due to the withdrawal of water at the cold and warm water intakes, lethal or sublethal effects of biocide releases and thermal alterations, and nutrient redistribution from the discharge plume. These concerns are also potentially those which would affect the fisheries to the greatest degree (Matsumoto 1983).

Assessment of the impact of OTEC facilities upon marine fisheries will depend on simulation models which provide the basis for bringing the results of preoperational data and environmental impact studies into perspective. The goal of these models is to minimize the environmental effects in the design of OTEC plants.

This report describes the techniques in obtaining the types of information required to develop predictive models for assessing the impact upon fisheries by the major concerns resulting from OTEC operations.

II. ASSESSMENT TECHNIQUES FOR FACTORS THAT MAY AFFECT FISHERIES

A. Impingement

Previous studies on environmental impacts of OTEC operations have labeled impingement as a major concern. Impingement occurs when certain nektonic and large planktonic organisms with limited avoidance capabilities are pulled and trapped against the intake screens due to the force of the water being drawn into the plant during normal operation. Sullivan and Sands (1980) classified impingement as not only an environmental issue but also as an economic concern to plant operations because of maintenance costs of cleaning the intake screen and plant downtime.

1. Organisms affected

The organisms most likely to be impinged in estimated screen mesh size of 0.95 to 1.3 cm (Sands 1980) are the micronekton, namely small epipelagic and mesopelagic fishes, macroplanktonic crustaceans, cephalopods, and other gelatinous invertebrates. Assuming 100% mortality of impinged organisms, the environmental concerns focus upon the potential reduction in the local

populations and populations of the impinged forms downstream of the plant. In addition, the impingement of micronekton may indirectly affect nektonic species through food chain interactions ([U.S.] NOAA 1981).

Regarding the proposed OTEC plant at Kahe Point, Hawaii, Matsumoto (1983) reviewed past research results on the distribution and behavior of commercial pelagic fishes and concluded that there should be no immediate effect on the fisheries due to impingement at either the warm water or cold water intakes (with intake velocity = 0.25-0.30 m/sec) since the adults of the commercially important species should not be affected. Matsumoto, however, expected impingement of juveniles and larval forms of some commercially important inshore species which inhabit offshore surface waters near the warm water intake.

2. Assessment techniques

The available data and literature are insufficient to fully evaluate the direct and indirect effects of impingement on commercially important species. Assessment of impingement effects on fisheries begins with the determination of species and abundance of organisms subject to impingement. Because micronekton are highly susceptible to impingement, catches by midwater trawls could provide clues to species and numbers likely to be impinged; however, trawls are typically fished at 1.5 to 2.0 m/sec, speeds which are about five to seven times the intake velocity of an OTEC facility. Therefore, the number and species of organisms captured in a trawl will be greater than those actually entrained since the avoidance capabilities of the organisms relative to the OTEC intakes are greater than they are to a trawl.

Although several different trawls have been used in the past to sample midwater fishes (Matsumoto 1961; King and Iversen 1962; Higgins 1970; Clarke 1973; Maynard et al. 1975), the most success in capturing micronekton has been achieved by the 10-ft Isaacs-Kidd midwater trawl (IKMT) and the anchovy No. 2 Cobb pelagic trawl (CT).

The IKMT (the more commonly used trawl of the two) was originally designed by Devereux and Winsett (1953). Although the net has remained the same with respect to design dimensions and mesh sizes, slight modifications have been made, usually to the cod end to serve the various needs of the collectors. In a study designed to collect juvenile tunas, King and Iversen (1962) used a cod end with 12.7 mm (1/2 inch) mesh and made of No. 207 nylon lined with coarse silk grit gauze or fine meshed nylon netting. In a general assessment of mesopelagic micronekton, Maynard et al. (1975) used a 1.0 m diameter plankton net of 0.333 mm Nitex¹ mesh for the cod end as did Clarke (1973).

¹Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Although the IKMT is preferred as a quantitative sampling tool over the CT, Matsumoto (1961) and Higgins (1970) found that the ability of a larger trawl to catch juvenile forms of commercial species such as tuna was much greater than that of the 10-ft IKMT.

Both Matsumoto (1961) and Higgins (1970) modified large pelagic nekton nets to sample the micronekton. Matsumoto (1961) modified the British Columbia midwater trawl (BCMT) (Barraclough and Johnson 1956) with a cod end of 6.4 mm (1/4 inch) mesh, whereas Higgins (1970) used the BCMT as well as a modified CT, which was two-thirds the size of the original Cobb trawl (McNeely et al. 1965). The CT is used in present assessment studies of the mesopelagic fauna by the Southwest Fisheries Center Honolulu Laboratory (HL). The modified CT has a headrope and footrope 30.9 m long, a mouth opening of 96 m², and a cod end which has an outer portion of 38-mm stretched mesh 24-thread (210-denier) nylon netting, and an inner liner of 6.3-mm stretched mesh, 6-thread (210-denier) nylon netting.

Sampling can be conducted using horizontal tows at the desired depths, oblique tows, or step oblique tows. A horizontal tow is made by simply lowering the trawl to the desired depth and towing horizontally for a predetermined time subject to the needs of the collectors. To attain the desired depths, time-depth recorders (TDR) can be used to determine depth independent of wire angle; however, if not available, estimation of the amount of cable required to reach the desired depth can be calculated before the tow. Such calculations of trawl depth are based on measurements of wire angle and wire out as described by Hida and King (1955). On oblique tows, the trawl is lowered to the desired depths and hauled through the water column or is towed from the surface to the desired depth and back to the surface. The step oblique tow involves lowering the trawl to the desired depth and towing it horizontally, then progressively raising it to the next desired depth and continuing the haul to the surface. Matsumoto (1961) found that this method resulted in a higher percentage of hauls containing juvenile tunas (57% versus 25% as compared with horizontal tows). No comparisons were made with oblique tows.

Other acceptable sampling gear for micronektonic organisms include some of the multiple net samplers, such as the multiple opening-closing net and environmental sensing system (MOCNESS) (Wiebe et al. 1976), the Bedford Institute of Oceanography net and environmental sampling system (BIONESS) (Sameoto et al. 1980), and the rectangular midwater trawl (RMT) series (Baker et al. 1973). With these types of gear, discrete vertical samples can be obtained. Such discrete depth information collected on a diel basis would be beneficial to an assessment study.

B. Entrainment

1. Vital communities affected

In entrainment, organisms small enough to pass through the intake screens are drawn into the system and exposed to sudden temperature and pressure changes as well as mechanical damage. For a proposed OTEC plant with estimated screen mesh size of 0.95 to 1.3 cm, marine organisms smaller

than 3 to 4 cm long, including phytoplankton, microplankton, zooplankton, ichthyoplankton and micronekton, will be entrained (Sands 1980). Sands predicted 100% mortality for organisms entrained by an open-cycle plant or at the cold water intake of a closed-cycle plant due to the inner plant stresses. Although percent mortality for entrained organisms at the warm water intake of a closed-cycle plant was not determined, Sands anticipated a significantly higher entrainment rate at the warm than at the cold water intake. Any significant impact due to entrainment will probably be a result of the mortality of organisms entrained at the warm water intake.

Matsumoto (1983) suggested that ichthyoplankton would be the major fisheries-related organisms affected directly by entrainment (in particular at the proposed Kahe Point site). More specifically, the larvae of tunas and billfishes and the pelagic larval forms of snappers, groupers, and jacks represent the greatest concern. Matsumoto (1983) also suggested that although eggs would be entrained, tuna eggs are buoyant and would be found above the intakes at or near the surface. Studies on various commercial bottom fish species conducted at the HL indicate that eggs of these species are also buoyant. Therefore, as concluded by Matsumoto (1983), the amount of eggs entrained may be small and impact important commercial fisheries little, if any.

2. Assessment techniques

Without an existing operational facility to monitor, assessment techniques are truly limited. Baseline information will be required and obtainable before plant construction. Predictive models generated from available biological data will supply a relative assessment of the potential effects of the resultant environmental stresses and ecological perturbations. The models should reflect not only the information regarding mortality (lethal) effects but should also consider the sublethal effects (Rosenthal and Alderdice 1976).

The assessment of distribution and abundance of ichthyoplankton which will provide baseline data, involves sampling methods similar to those employed by King and Demond (1953), Matsumoto (1958), Strasburg (1960), Nakamura and Matsumoto (1967), and Miller (1979) in their studies on tuna larvae or the discrete depth sampling methods described by Clarke (1969), Wiebe et al. (1976), and Sameoto et al. (1980). Most of the tuna larvae were collected in 1-m, fine mesh plankton nets equipped with a flowmeter to estimate the water strained. A detailed description of the gear can be found in King and Demond (1953). The tows, either oblique or surface hauls, lasted from 15 to 60 minutes; most were about 30 minutes.

The meter ring nets, however, have their disadvantages. Obstructions at the mouth of the net during a tow from the bridles are believed to increase the potential for avoidance of the net by organisms. Newer designs, including many of the multiple net samplers, have adopted versions of the rectangular net described in Tucker (1951). The design eliminates any obstruction in front of the net mouth when fishing.

Meter ring nets were also inadequate for the needs of researchers desiring discrete depth collections since contamination from organisms captured during the ascent or descent of the net was inevitable. Several variations of opening and closing nets were thus developed. Among these is the opening-closing Tucker trawl (Clarke 1969) based on the rectangular net design by Tucker (1951).

The trawl consists in part of a series of horizontal bars of which the top and bottom bars are fixed. The bars between the fixed set slide along wires attached to the top and bottom bars to open and close the nets at desired depths. The opening and closing triggering mechanisms can be controlled with acoustic and telemetering equipment or mechanical messengers. The net was designed to fish with the mouth at 45° from the vertical, forming a square to the front and sampling an area of 8 m².

The MOCNESS is similar in principle to the Tucker trawl but carries nine rectangular nets (1 x 1.4 m). It is further equipped with environmental sensors to measure conductivity, temperature, and depth. Sensors to monitor water flow, net angle (from the vertical), and the opening and closing of the nets are also included (Wiebe et al. 1976).

The BIONESS adds one modification to the MOCNESS and Tucker net arrangement. Rather than having nets and their closing bars stacked vertically, making the front profile much larger than the mouth opening of a single net of the sampler, the nets and closing bars are arranged horizontally in the BIONESS. This eliminates the highly visible structures of the frame and makes the front view inconspicuous and streamlined for smoother water passage. Sensors for temperature, conductivity, depth, illumination, and water flow, among others, are part of the BIONESS sampling system.

Other gear used in assessing the abundance and species composition of ichthyoplankton are neuston and bongo nets. These were utilized by Hirota (1977) in his study of zooplankton at the Deep Ocean Mining Environmental Study area. Bongo nets are also available in opening-closing versions to take discrete depth samples.

3. Inner plant mortality

Entrained organisms are expected to be subjected to considerable stress including sudden thermal and pressure changes, exposure to antifouling biocides (probably chlorine), and mechanical damage resulting from abrasion and collision with structures. Using data from cooling water intakes of coastal power plants, Marcy (1975) found mortalities of fish eggs and young passing through power plants to be between 39 and 100%; the vast majority was near 100%. As indicated by Hoss and Peters (1983), research on environmental effects of coastal marine power plant operations have provided general information for use in initial evaluation of potential OTEC environmental problems. A study on the cooling water system of a Connecticut nuclear power plant indicated that of the near 100% mortality of nine species of young fish, 80% of the mortality was due to

mechanical damage, 20% was due to thermal shock, and no measurable mortality due to presence of biocide (Marcy 1973).

a. Thermal effects on entrained organisms

Although many studies have been conducted on temperature effects on fish larvae and eggs, none are based on tropical species such as those that may be found at OTEC sites in low latitude regions. Therefore, once the major species affected by entrainment at an OTEC facility are established, temperature tolerances for those species must be determined to obtain estimates of mortality attributable to sudden temperature changes.

Two of the methods for determining lethal temperature for ectothermic animals have been described by Hutchison (1976) and Talmage and Opresko (1981). Hutchison's method measures resistance times of fish that were previously acclimated to a wide range of temperatures in the laboratory. These measurements are made for various constant test temperatures. In this method, the organisms are abruptly exposed to test temperatures and the resulting measurements are subjected to statistical treatment for determination of lethal temperatures. A median tolerance limit (TL₅₀), which indicates the temperature at which 50% of the fish survive for a designated period of time, is then calculated. This lethal threshold is the upper (and similarly the lower) incipient lethal temperature. From this, one can determine the ultimate incipient lethal temperature of the species.

The other method to determine lethal temperatures called the "critical thermal maximum (or minimum)" (CTM) (Fry 1971; Hutchison 1976; Talmage and Opresko 1981), is the temperature at which the animal dies or becomes visibly incapacitated while exposed to a constant rate of change. The procedure allows deep body temperature to follow the test temperatures without a significant time lag. The rate is usually 1°C every few minutes.

b. Effects due to pressure changes

Entrained organisms will also be subjected to rapid changes in hydrostatic pressure. Hoss and Blaxter (1981) subjected larval herring to different series of pressure changes to simulate passage at a coastal power plant's cooling water intake. The study involved acclimation and rapid pressure increases followed by rapid decompression. Subsequent mortality and behavior were observed. Such studies should be conducted for the commercial tropical species that would be potentially affected.

c. Effects due to biocides

In a commercial OTEC plant, the biocide most likely to be used will be chlorine, which will be routinely released into the heat exchangers to control biofouling. Numerous studies have been conducted on power plant chlorination and its effects upon estuarine and marine systems; these have been summarized in Hall et al. (1981). In a study on mortality of entrained fishes, none of the mortality could be attributed to the presence of chlorine (Marcy 1973). When considering combined stresses, however,

Hoss et al. (1975) suggested a synergistic interaction between chlorine and temperatures above ambient. This was based on the findings of an increased sensitivity of the test species to chlorine with the elevated temperature.

Studies on chlorine toxicity on marine animals of direct application to OTEC plants were conducted by Venkataramiah et al. (1981a, 1981b). They utilized bioassays to define sublethal, incipient lethal, and lethal concentration ranges of chlorine, the 96-hour lethal concentration for 50% mortality (LC₅₀), and the lethal time for 50% mortality (LT₅₀) for each of the test species (mullet, Mugil cephalus, and sargassum shrimp, Latreutes focorum). They also studied the effect of size on the test species' LC₅₀ and LT₅₀. The sublethal concentration range was defined as the narrowest range in which none of the organisms, subjected to subsequently narrower concentration ranges, died due to toxicity. The incipient lethal concentration range was defined as the range in which some of the animals (but not all) died, and lethal concentration range as that in which they all died. Continuous flow-through seawater systems were used for the bioassays.

Similar studies should be conducted on the commercial species (such as tuna larvae) that are subject to entrainment to provide estimates of inner plant mortality due to biocide presence.

d. Effects due to mechanical damage

The mortality due to mechanical damage represents deaths of organisms from abrasions and collisions resulting from turbulence and pressure changes in passage through the system. Marcy (1975) concluded that mechanical damage was the highest single cause of entrainment mortality based on numerous power plant studies.

The assessment of the effects due to mechanical damage at a proposed OTEC facility, however, is a difficult one. Past studies at coastal power plants have had the benefit of monitoring cooling water intakes, so a direct count of dead versus live organisms after passage through the plant was available. Such data will not be available for an OTEC preconstruction assessment.

One experimental method that provided conservative estimates of mortality due to mechanical stress for a given entrained fish species was described by Morgan et al. (1973). Their experiments on white perch and striped bass measured the mortality caused by the shear fields that are created by water movement over the surface of fish eggs and larvae. Shear fields were defined as the variation in water velocity with respect to time, expressed as units of force per unit area (dynes/cm²).

4. Entrainment effects on supportive food chains

One aspect of entrainment that also must be addressed is the effect entrainment will have on supporting food chains of recreationally and commercially important fishes. Feeding studies have been conducted for many of Hawaii's commercial fish species that are apt to be affected,

namely the pelagic tunas (Reintjes and King 1953; King and Ikehara 1956; Iversen 1962; Alverson 1963; Waldron and King 1963) and mahimahi (Palko et al. 1982).

The procedures for food studies of fishes in general are similar. A review of food study methods and their application is described in Hyslop (1980). In food studies conducted at HL, stomach contents are sorted into identifiable groups and measurements of prey volume (water displacement method), prey length (if possible), and sometimes prey weight are taken. The numbers of prey items are also recorded. Identification methods of the forage items include the use of vertebral counts and morphology, scales, and otoliths for fishes, beaks and pins for cephalopods, and exoskeletal remains for crustaceans. To determine the importance of the forage items to the predator, numerical, volumetric, and frequency of occurrence systems of analyses and methods have been used to express the results. Pinkas et al. (1971) incorporated these three traditional methods of stomach analysis in the development of an index of relative importance (IRI). The IRI provided insight to the rankings of forage items within the diet.

To estimate the forage organisms that would be entrained involves trawling targeted at micronekton (King and Iversen 1962; Blackburn and Laurs 1972), a procedure similar to that described earlier under impingement effects.

It does not appear that food chains of the commercial demersal fishes such as snappers and groupers will be directly affected by entrainment mortality. Bottom fish food studies in Hawaii have revealed that they fed predominantly on benthic organisms (Humphreys in press; Seki in press a, in press b). Water column prey items, when taken, were generally large and would possess enough swimming strength to avoid entrainment. Since the benthos gets energy from the pelagic environment, however, there may be indirect effects through the lower trophic levels.

C. Biota attraction

1. Open-ocean plant ships

Assessing the potential OTEC impact upon fisheries due to biota attraction requires two approaches, that is, attraction due to an open-ocean plant ship and that resulting from facilities constructed on or near the shoreline. The attraction properties of an open-ocean plant ship appears analogous to those of organisms collecting around flotsam and fish aggregating devices (FAD's). Facilities near the shoreline in which pipes and foundations are placed in shallow water or onshore will act as artificial reefs (Seki 1983).

Gooding and Magnuson (1967) and Matsumoto et al. (1981) studied attraction of animals to artificial open-ocean structures. To describe faunal abundance and diversity, especially of the smaller juvenile forms, direct observations were the most useful. Observations were either made by divers or from an observation chamber of a raft. To monitor the commercial species attracted to FAD's, Matsumoto et al. (1981) also conducted

trolling, recorded sightings of bird flocks and fish schools, and scanned for subsurface fish schools utilizing hydroacoustics. Fish catch data from commercial tuna pole-and-line boats visiting the monitored FAD's were also used to assess the effectiveness of the structures as attractants.

Fish catch data from trolling operations and from commercial boat data will provide catch per unit effort (CPUE) which is one of the most commonly used techniques for environmental monitoring. The CPUE is defined as the catch divided by the effort exerted to obtain that catch. The catch will generally be measured in numbers or weight. The effort per unit time can be in terms of tows, hauls, fishing trips, number of vessels, or number of anglers. The major disadvantage to using this method, primarily when using commercial catch data, is the difference in gear and effort which makes analysis difficult. However, CPUE from trolling operations and commercial catch data is probably the most effective method of monitoring migratory species at a specific locality.

2. Nearshore facilities

Nearshore OTEC facilities, especially the proposed tower design, will also require evaluation of the attraction of offshore migratory commercial species. In addition, artificial reef effects created by the structure's presence must also be assessed. This involves possibly using bottom drift fishing (bottom handline) and trapping to assess the impacts on the commercial demersal species.

Studies on inshore artificial reefs have generally utilized fish transects to inventory species composition and estimate density. Briefly, this method involves the laying down of a premeasured transect line along which fish species on both sides of the line are identified and counted (Brock 1954). Other methods that will supplement the transect data in determining species composition are hook and line, throw net, and spearing.

Various species of tunas, squids, and carangids are the major commercial marine animals that are caught by the use of night lights and various types of fishing gear including handlines, dip nets, pole and line, and jigging machines. In a recent 5-year survey of the fishery resources in the Northwestern Hawaiian Islands conducted by the HL, night-light fishing was among the methods used in assessing species composition and density of the resources. The light (a 1,500-W bulb) was initially submerged to 21.3 m (the maximum amount of wire out). After about an hour, the light was raised and eventually dimmed to concentrate the organisms, facilitating observation and capture. The raising and dimming of the lights drew organisms farther down in the water column closer to the surface.

III. SUMMARY

The assessment of the impact of OTEC facilities on fisheries without an existing operational plant will have to rely on the use of models based upon available biological data. This report describes some of the techniques in obtaining the types of information required for the model development. With regards to fisheries, the effects due to organism

impingement, entrainment, and attraction have been identified as the major areas of concern.

The organisms most likely to be affected by impingement at the intakes would be the micronekton. The use of midwater trawls such as the IKMT, the CT, or the RMT series (for discrete depth sampling) could provide clues to the species and numbers of organisms likely to be impinged.

Multiple net samplers such as the MOCNESS, the BIONESS, and the Tucker trawl will sample the entrainable marine organisms smaller than 3 to 4 cm in length. For ichthyoplankton, using these multiple nets allow sequential discrete depth sampling, which is most important. In past studies meter ring nets, bongo nets, and neuston nets have also been used to sample ichthyoplankton.

The organisms entrained will be subjected to the stresses of inner plant mortality. These include sudden thermal and pressure changes, exposure to antifouling biocides (probably chlorine), and mechanical damage resulting from abrasion and collision with structures. Knowledge of sublethal and lethal limits when exposed to the stresses for the potentially affected species is needed, especially for tropical species.

Assessment of the attraction effects on fisheries involves addressing environments created by open-ocean and nearshore facilities. Direct observations (by divers or subsurface chambers), catch results from trolling operations, and commercial catch data have been used to monitor open-ocean localities. Abundance and diversity of commercial demersal species settling on artificial reefs created by nearshore facilities can be obtained by catch data from bottom handlining and trapping. Fauna that have taken residence on inshore artificial reefs have generally been assessed by using direct observations on line transects and catches from throw nets, spearing, and hook and lines.

Organisms attracted to night lights can be captured with various types of fishing gear including handlines, dip nets, pole and lines, and jigging machines.

These are some of the methods that have been used to sample in either analogous situations or potentially impacted areas produced by the presence and operations of a commercial OTEC facility. Information obtained from such sampling and experimental methodologies can be used in developing predictive models which in turn can be applied to plant design strategy to minimize the environmental effects.

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POTENTIAL IMPACT OF OCEAN THERMAL ENERGY CONVERSION (OTEC) OPERATION ON FISHERIES

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I. INTRODUCTION

A collaborative study to address the potential impact of ocean thermal energy conversion (OTEC) operations to fisheries was initiated between the Office of Ocean Minerals and Energy (OME) and the National Marine Fisheries Service (NMFS) in June 1982. Since then, several sub-studies describing the OTEC operating conditions, the compilation and syntheses of pertinent biological and fishery information, syntheses of information on entrainment, impingement, biocides, nutrients, trace metals and attraction-avoidance effects have been completed.

This report documents the potential impact of OTEC operations on fisheries based on the various substudies.

II. OPERATING CONDITIONS

The basic requirement for an OTEC plant is an adequate temperature difference, an annual minimum difference of 20°C, between the surface water and water at a depth of about 1,000 m. Warm water drawn from the ocean's surface provides heat which is transferred through a heat exchanger to a working fluid. The working fluid is evaporated and the resulting high-pressure vapor is used to drive a turbine to produce electricity. Cold water pumped from the deep condenses the subsequent low-pressure vapor in a second heat exchanger, and the working fluid is then pumped back and recycled. The mixture of warm and cold water is discharged at a depth where it will be least harmful to the environment (Uchida 1983).

A. OTEC Sites

Areas of a minimum difference of 20°C between surface and deep water can be found year round over a vast expanse of the oceans in the tropics between lat. 20°N and 20°S. However, sites that would provide maximal usage by an OTEC plant would be governed also by other criteria, such as, bottom topography and profile, tidal, wind-driven and inertial currents, mass transport by waves, climatic conditions, and economic zone considerations. The last could affect the placement of floating plant ships in open waters where the economic zones of two or more countries overlap, but will not be a concern to shoreside or nearshore facilities, which will be well within the zone.

Uchida (1983) lists a number of places that would be adequate for possible land-based OTEC facilities in the Pacific. These include the Hawaiian Islands, Cabras Island off Guam, Manila, the Republic of Nauru, Taiwan, Mexico, French Polynesia, and New Calendonia. Hoss et al. (1983) list Puerto Rico and the Virgin Islands as possible localities that would be accessible to American corporations in the Caribbean Sea. At all of these localities one or more sites were identified as being suited for OTEC operations.

Sites for early U.S. development of OTEC plant operations have been narrowed to Kahe Point, Oahu, Hawaii near the O'OTEC benchmark sites (Fig. 1)

in the Pacific, and southeastern Puerto Rico (Fig. 2) in the Caribbean. In both places depths of 1,000 m are located within 3.8 nmi from shore.

B. Site Characteristics

1. Temperature, salinity, and density profiles

Off Kahe Point the surface temperature varies from 24.1°C in winter to 26.9°C in summer and has a range of $\pm 1.2^\circ\text{C}$ in both seasons. The temperature ranges from 5.2 to 5.5°C at 700 m and is about 4.2° at 1,000 m. The depth of the surface mixed layer varies from 10 to 140 m, and the most probable depth varies from 40 to 100 m. The mixed layer is shallowest in summer and deepest in winter. The salinity near the surface is about 34.84 ppt, and a salinity maximum of 35.10 ppt is at a depth of 100 to 125 m and a salinity minimum of 34.15 ppt at a depth of 450 m. The density profile is dominated by the temperature, but salinity variation has some effect especially because the salinity maximum occurs near the thermocline (Ditmars and Myers¹).

Off southeastern Puerto Rico the temperature varies from 26.2°C in winter to 29.2°C in summer and has a range of $\pm 1.5^\circ\text{C}$ in both seasons. It is 7.9°-8.2°C at 700 m and 5.3°C at 1,000 m. The depth of the mixed layer varies from 10 to 140 m. The salinity is about 35.1-36.1 ppt at the surface, and 36.7 ppt at 100-175 m; a salinity minimum of 34.9 ppt is at 700-900 m (Ditmars and Myers footnote 1).

2. Currents

Being combinations of tidal currents, geostrophic flow, and wind-driven currents, the currents off Kahe Point are fairly complex. These currents are highly variable in magnitude and direction. The semidiurnal tidal current is 20-30 cm/s, the diurnal tidal current is 10-20 cm/s, the geostrophic flow is about 15-25 cm/s, and the wind-driven current ranges from 9 to 10 cm/s. The flood-tide current and wind-driven currents roughly parallel the shoreline. The mean flow is estimated to be about 10 cm/s or less, and the net flow of the surface waters tends to be generally westward (Ditmars and Myers footnote 1).

In the vicinity of southeastern Puerto Rico, the currents generally flow westward, parallel to the shoreline. The mean current is typically 10-40 cm/s in the deep offshore waters (>1,000 m) and slightly higher (ca. 60 cm/s) near shore (Ditmars and Myers footnote 1).

¹Ditmars, J. D., and E. P. Myers, National Marine Fisheries Service Argonne National Laboratory and National Ocean Service, Chicago, IL. Preliminary estimates of the range of operating conditions expected for initial OTEC deployments. Manuscript prepared for OTEC Program, Office of Ocean Minerals and Energy, Washington, D.C.



Figure 1.--Potential OTEC site off Kahe Point, Hawaii.

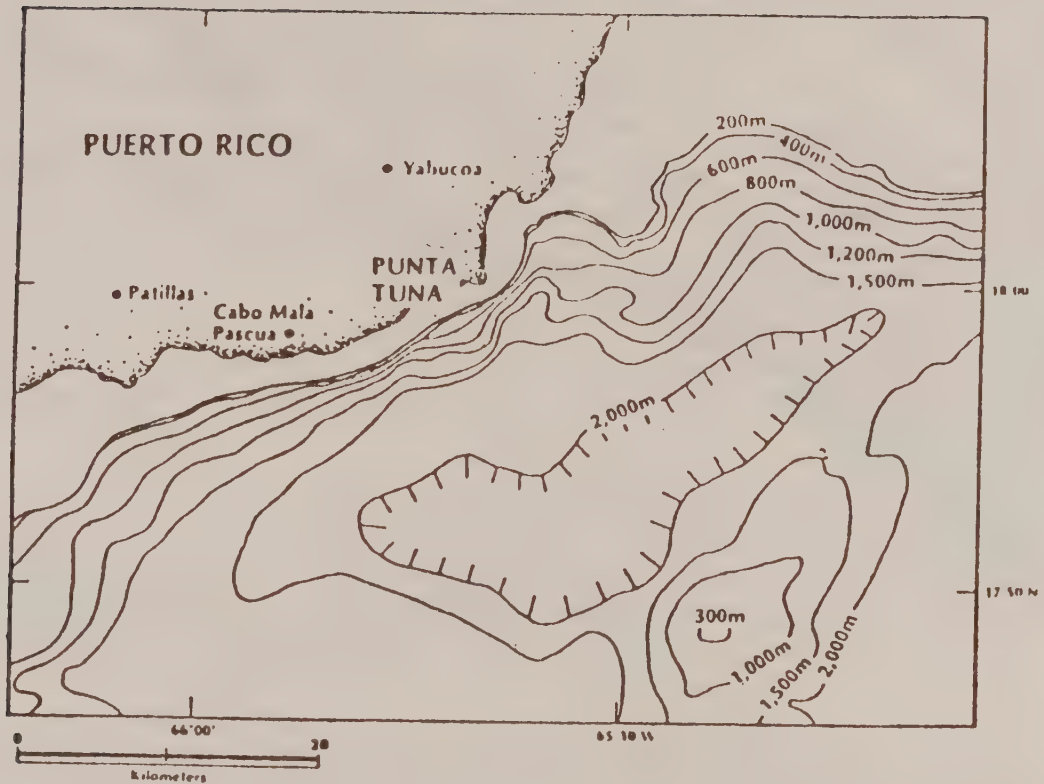


Figure 2.--Bathymetry near potential OTEC site at Punta Tuna, Puerto Rico (Sullivan et al., 1981).

C. Plant Characteristics

1. Type, capacity, and dimensions

General plant characteristics for OTEC are addressed in Ditmars and Myers (footnote 1) and are briefly summarized here. The first OTEC plants are expected to be of the closed-cycle type using ammonia as the working fluid (Fig. 3). They will be small, about 40-MW and will probably be located on or near shore or on bottom-mounted towers in about 100 m of water. A typical shore-mounted plant might be made of four 10-MW units and have horizontal dimensions of about 100 m. Bottom-mounted plants (on towers) will utilize the space along the vertical extent of the tower and thus will have horizontal dimensions of about 50 m. The heat exchangers will be made of aluminum or titanium and biofouling will be controlled by periodic chlorination.

WARM WATER INTAKE

Depth: 20m

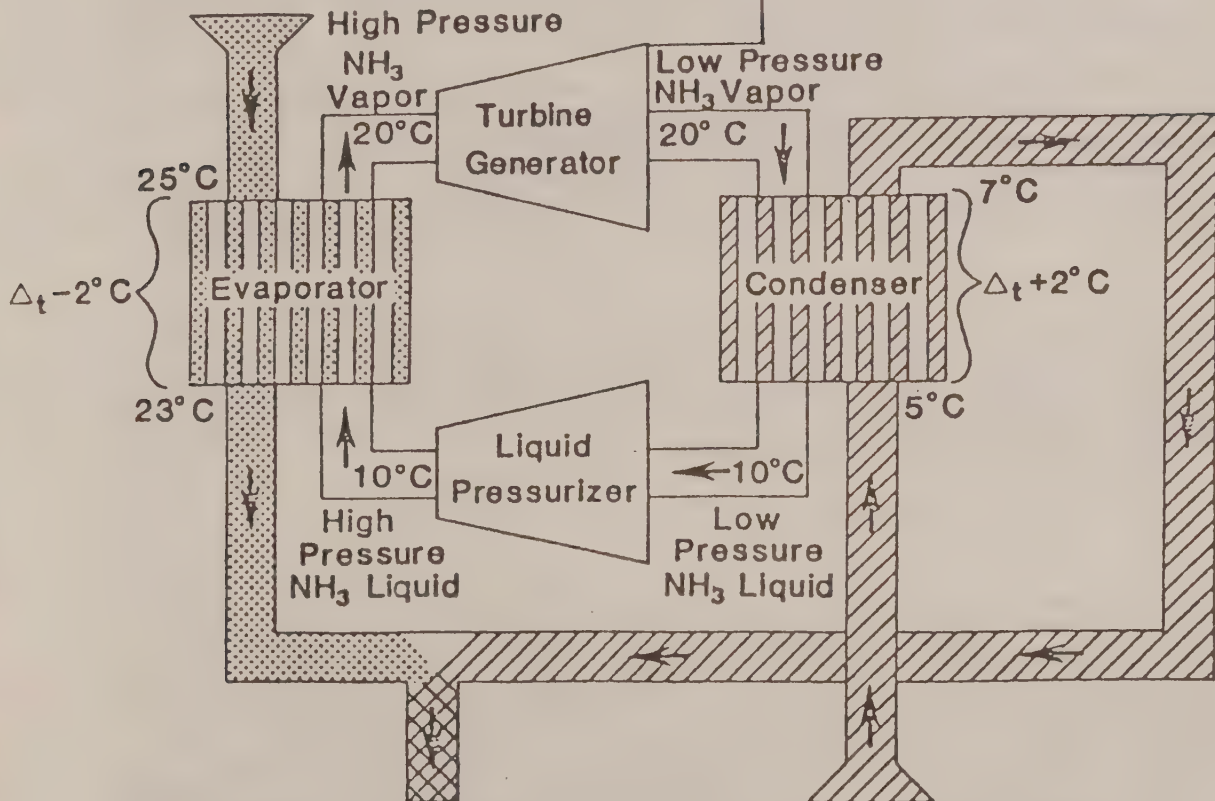
Flow Rate: $4\text{m}^3/\text{s}$ per MW_e

Flow Velocities:

Outside intake, $0.25\text{--}0.30\text{m/s}$

In pipe, $1.5\text{--}2.5\text{m/s}$

Electric Power
Output



MIXED DISCHARGE

Depth: $>30\text{m}$

Flow Rate: $8\text{m}^3/\text{s}$

Flow Velocity: $1.5\text{--}2.5\text{m/s}$

COLD WATER INTAKE

Depth: $750\text{--}1000\text{m}$

Flow Rate: $4\text{m}^3/\text{s}$ per MW_e

Flow Velocity: $1.5\text{--}2.5\text{m/s}$

Water Temp: 5°C

Figure 3.--Schematic diagram of a closed cycle OTEC system (Hoss and Peters 1983).

2. Operation

a. Warm and cold-water intakes

The warmwater intake pipe will be 9.2 m in diameter and the intake will generally be located between 10 and 20 m deep, depending upon the size of the plant. The intake structure will be modified so that the horizontal dimension will be larger than the vertical dimension to reduce the intake velocity. Thus, whereas the velocity of flow in the pipes will generally be in the 1.5-2.5 m/s range, that outside of the intake structure will be 0.25-0.30 m/s. The typical warmwater flow rate will be about 4 m³/s/MW. At this flow rate, roughly 13.8×10^6 m³ of water will flow through the warmwater intake in a 40 MW plant each day.

A screen placed at the intake will prevent large organisms from entering the water system and clogging the heating pipes in the heat exchangers. The screen mesh size is not known; however, following a generally accepted criterion that mesh size should equal half the diameter of the heat exchanger tube and based on the projected size of exchanger tubes plants, the screen mesh size could be about 1.3 cm (Sands 1980).

The cold-water intake pipe also will be 9.2 m in diameter and 915 m long. Because the cold-water intake will be too deep to monitor the intake screen, the water will be passed through a sump within the plant where a screen could be placed to strain out the large organisms. The cold-water flow rate (4 m³/s) and the velocity of flow in the pipe (1.5-2.5 m/s) will be comparable to those in the warmwater pipe.

b. Discharge

Most OTEC designs try to locate the discharge so as to reduce the potential for recirculation into the warmwater intake and depend on the density of the effluent being greater than that within the mixed layer so that the effluent will come to equilibrium below the mixed layer. The discharge port or ports are usually the open end of a round pipe directed either downward or horizontally, often with a downward component. For nearshore plants this may involve the use of discharge pipes leading offshore. In deeper waters the discharge will be located generally deeper than 30 m, most likely at 100 m, to avoid recirculation into the warmwater intake pipe.

The discharge flow rate will equal the intake flow rates of both cold and warm water. For a 40-MW plant, Wang² states that the flow rate of the 15°C mixed discharge water will be 280 m³/s, that in the open ocean, the

²Wang, D.-P. National Marine Fisheries Service Argonne National Laboratory. A far-field model for regional influence of OTEC operation. Manuscript prepared for OTEC Program, Office of Ocean Minerals and Energy.

near-field effect of the effluent is characterized by a jet with high initial speed (order 1 of m/s) and rapid dilution (order of 10), that the far-field effect is characterized by a buoyant plume which will drift at about the ambient ocean current speed and spread laterally due to gravity, and that the transition from a near-field jet to a far-field plume typically takes place at a distance of a few hundred meters from the plant.

III. FACTORS THAT MAY AFFECT FISHERIES

The OTEC operation will withdraw large volumes of warm and cold water. The major impacts of this withdrawal are impingement of organisms on the intake screens, primary entrainment of organisms through the OTEC plant, and the deleterious effects of the discharge on the environment (secondary entrainment). The type and degree of impact will depend largely upon the location of the intake, the rate of withdrawal, and the density of organisms at the intake and discharge. In general, phytoplankton, zooplankton, and micronekton can be expected to sustain maximum effects, whereas the nekton will suffer lesser effects. Those fish whose entire life stages, from zooplanktonic to nektonic, occur at the intake depths will be subjected to impingement and entrainment.

A. Impingement

Impingement occurs when organisms too large to pass through the intake screen are pulled against it and are unable to escape due to the force of the withdrawn water. Screen mesh size, biomass concentrations, and volume of water circulated are primary factors of impingement. In most fishes, body length is usually three times the body depth, so that fish larger than about 4 cm long and with limited avoidance capabilities may be impinged on the intake screens. Those with deeper or wider bodies will be impinged at smaller sizes.

The only available information on the density of fish that is usable to estimate the effects of OTEC operation is from midwater trawl tows. Based on such data from an area farther offshore (10-25 km) and to the north of Kahe Point (Maynard et al. 1975), Sands (1980) estimated that 130 kg of micronekton would be impinged daily in the warmwater screen and 82 kg in the cold-water screen, in a 40-MW plant. Since fish comprised 51.9% in weight of the micronekton standing stock (Maynard et al. 1975), the estimated biomass of fish impinged would be about 67 kg per day on the warm-water screen and 43 kg per day on the cold-water screen.

B. Primary Entrainment

Marine organisms small enough to pass through the 1.3 cm intake screen (Sands 1980) will be entrained in the seawater flowing through the heat exchangers and be exposed to various stresses resulting from rapid changes in temperature and pressure, abrasion and collision with structures, and exposure to biocide and other toxic substances that might result from plant operation.

1. Temperature

Organisms passing through the OTEC plant will be exposed to cold and warm thermal effects. Fish eggs and larvae entrained in the warmwater intake pipe will be exposed to sudden cooling as the warm intake water (26°C) is mixed with the cold intake water (5-7°C), and to sudden warming as the mixed water (about 15°C) is ultimately discharged at a depth of about 100 m. At Kahe Point, the ambient temperature at this depth is 21-24°C (Noda et al. 1981). The entrained fish eggs and larvae thus will be exposed to successive changes in temperatures of -11°C at mixing and +6°-9°C at discharge. Although the exposure time in the mixed water will be brief (<1-2 min), the cold shock of -11°C may be large enough to cause fish larvae and juveniles to lose equilibrium and thus become susceptible to increased predation, and eggs and larvae to suffer mortalities.

Susceptibility to increased predation has been found for juvenile channel catfish exposed to cold shocks of -6°C or more (Coutant et al. 1976), and young bluegill exposed to cold shocks of -9°C (Wolters and Coutant 1976). Juveniles of American shad acclimatized at 21.1°C suffered mortalities of 90 and 100% when exposed to coldshocks of -8.3° and -13.9°C, respectively (Tagatz 1961); mature alewife acclimatized at 21°C suffered 30 to 100% mortalities when exposed to cold shocks of -10.5° to -16°C (Otto et al. 1976), and shad that had lost equilibrium from cold shock for 12 s before being returned to warm water suffered as much as 32% mortality (Griffith 1976). Although these were all freshwater fish, similar effects could prevail among marine species.

Fish eggs, larvae, and juveniles entrained in the cold-water intake pipe will be exposed to sudden warming of +10°C at mixing and another 6°-9°C at discharge, for a total Δt of 16°-19°C. Exposure to a Δt of this magnitude could result in loss of equilibrium among larvae and juveniles and even mortality in all three growth stages. Schubel and Koo (1976) observed that hatching success of eggs of blueback herring and American shad was significantly reduced at a Δt of 15°C in exposures of 10 min or longer and that excess temperature of 20°C resulted in nearly total mortality of the eggs. Other studies indicate that thermal shocks of 8°C produced moderate mortality in larvae of Atlantic silverside reared in 25°C water (Austin et al. 1975) and young alewife acclimatized at 10°C suffered 30, 60, and 100% mortalities in abrupt temperature increases of 16°, 16.5° and 17°C, respectively (Otto et al. 1976).

If oceanic fish eggs and larvae react to thermal changes in a similar manner, mortalities to those entrained in OTEC plant operations could be substantial. Based on the average densities of fish eggs and larvae at depths of 600-1,000 m off Kahe Point (data from Noda et al. 1981) and on the estimated intake flow rate, an estimated 48 million fish eggs and 83,000 larvae could be entrained daily in the cold-water intake and thus become exposed to thermal effects.

2. Biocides

Chlorine will most likely be used in OTEC plants to control biofouling. The U.S. Environmental Protection Agency (EPA) guidelines restrict the discharge of free chlorine to 2 h in any 1 day (EPA 1976). The allowable discharge concentration during these 2 h must average 0.2 ppm over 30 days, with a maximum of 0.5 ppm. At these levels of concentration, the majority of entrained organisms could be affected (Morgan and Carpenter 1978), however, damage to the organisms would be reduced greatly if exposure times are short. Effects on fish vary with age; larvae are more susceptible than juveniles, and eggs are more tolerant.

A recent study (Venkataramiah et al. 1981) on the toxicity of OTEC plant components on marine organisms has shown that total residual chlorine level of about 0.1 ppm or lower was not lethal to the test animals (juvenile mullet, Mugil cephalus, 25-75 mm long) and that 100% mortality occurred at a concentration of 0.289 ppm after 6.5 h of exposure. The study also indicated that toxic concentrations were size related, the resistance to chlorine increasing with fish size. Other studies on eggs and larvae showed that 0.032 ppm of free chlorine produced 50% mortality in early larvae of plaice, but there was no effect on eggs at chlorine levels of 0.75 ppm in an 8-day exposure (Alderson 1972); LC_{50} values for different stages of plaice and Dover sole larvae were below 0.10 and above 0.025 ppm at exposures of 48 and 96 h, respectively (Alderson 1974); and striped bass juveniles approximately 63 mm did not show significant mortality until after 1 h exposure to 0.16 ppm residual chlorine at t of 6.8°C (Lanza et al. 1975).

Since the exposure time through the plant is expected to be short (about 10-15 min in warmwater systems, 20-30 min in cold water systems), damage to entrained fish eggs and larvae from biocide may be relatively low. Assuming the worst situation, i.e., the larvae suffering 100% mortality and treatment applied for 2 h each day, at least 115,000 larvae could be expected to die daily in the warmwater system and 11,500 in the cold-water system from biocide treatment alone.

3. Physical damage

Fish eggs and larvae entrained in cold and warm intakes will be subjected to stresses similar to those encountered in powerplants. They will be stressed by rapid changes in hydrostatic pressure, velocity shear forces, buffeting and collision with other organisms, and collision with fixed or moving equipment, such as screens, piping and pumps (Marcy et al. 1978). Organisms entrained in the cold water pipe will be exposed to pressure changes of up to 100 atmospheres within a few minutes (Sands 1980). Entrained larvae and juveniles possessing a swim bladder would be vulnerable to pressure changes of this magnitude and would suffer mortality (Blaxter and Hoss 1979; Hoss and Blaxter 1979).

Studies on the effects and impacts of physical stresses on organisms entrained in powerplants (Marcy et al. 1978) show that fish eggs and larvae of many species of fish, including freshwater, estuarine, and some marine

species, suffered substantial mortality ranging from 30 to 100%. For most species, the mortality was between 90 and 100%. A similar study by Serchuk (1976) shows that juveniles fared better; total mortality ranged from 56.5 to 67.7%. Generally, physical damage was the major cause of mortality of entrained organisms, and the greatest damage occurred during passage through the pumps.

Whereas damage from biocide treatment is intermittent, damage from physical stresses will be continuous during the entire period the plant is in operation. Consequently, some investigators (Hoss and Peters 1983) believe that the major cause of entrainment mortality will be physical damage.

C. Secondary Entrainment

Most of the same stresses encountered in primary entrainment will also be encountered in secondary entrainment. These include stresses resulting from temperature changes, use of biocides, and turbulence caused by the mixing of the effluent with the surrounding water.

At the expected discharge depth of 100 m off Kahe Point, the 15°C effluent will mix with 21°-24°C water. Fish eggs and larvae in the latter would thus be exposed to a cold shock of -6° to -9°C followed by a rapid return to ambient temperature. Exposure to this cold shock could result in loss of equilibrium and some mortality.

Stress from biocide could occur among organisms entrained in the plume, largely as a result of prolonged exposure; however, rapid dilution of the effluent, resulting in reduced chlorine concentration and exposure time, could effectively reduce or eliminate stress from this source. The centerline dilution and chlorine concentration in the discharge plume is given by Sands (1980). With a 0.2 ppm chlorine concentration at the point of discharge, dilution to 0.05 ppm will occur at a downstream distance of 0.2 km. Based on a current flow of 11.1-18.4 cm/s at that depth (Noda and Associates 1982), this dilution will be reached in 0.3-0.5 h; dilution to 0.02 ppm will occur at a distance of 2.5 km in 3.8-6.2 h; and to 0.01 ppm at 5.0 km in 7.5-12.5 h. Comparing these values with the LC₅₀ values for plaice, 0.10 ppm in 48 h exposure, and Dover sole larvae, 0.025 ppm in 96 h exposure (Alderson 1974), it would seem unlikely that the chlorine concentration in the OTEC plume will be harmful to fish larvae.

Physical damage to fish eggs and larvae could be caused by acceleration and shear forces in the turbulent eddies created by the discharged water. Only limited studies have been made on the effects of acceleration and shear forces on aquatic organisms, and these have dealt mainly with passage of entrained organisms through powerplants (Marcy et al. 1978). Shear bioassay experiments by Morgan et al. (1976) indicated that juvenile Morone spp. begin to suffer mortality when the shear stress approaches three times the force of gravity. Studies on determining the intensity and effects of turbulence created by the discharge from OTEC plants have not been made. It is, therefore, difficult to predict the impact resulting from turbulence in secondary entrainment.

D. Attraction

The OTEC platform could act as a fish attracting device (Seki 1983) and congregate pelagic as well as inshore fishes. The lights at night will also attract juveniles and small fishes. The attraction will thus result in an increase of fish that would be susceptible to impingement and entrainment. Although the exact numbers of fish that ultimately become impinged and entrained in the plant intake systems cannot be estimated, due to the lack of sampling data, it could be significant.

IV. EFFECTS ON FISHERIES AT PREDICTED SITES

A. Hawaii

1. Fisheries affected

The most common commercially important species of fishes in Hawaiian waters are listed in Table 1. The major thrust of the commercial fishery is in the open ocean beyond the 200 m depth, where pole-and-line boats catch skipjack tuna, Katsuwonus pelamis, and longline, handline (ika-shibi), and commercial and recreational trolling boats, harvest deep- and surface-swimming yellowfin tuna, Thunnus albacares, bigeye tuna, T. obesus, albacore, T. alalunga, striped marlin, Tetrapturus audax, blue marlin, Makaira nigricans, black marlin, M. indica, swordfish, Xiphias gladius, shortbill spearfish, T. angustirostris, sailfish, Istiophorus platypterus, wahoo, Acanthocybium solandri, and dolphin, Coryphaena hippurus

Table 1.--Commercial fish catches for State of Hawaii:
Year ending June 30, 1976¹ (Sands 1980).

Species	Weight (lb)	Value of catch sold (in dollars)
Aku (skipjack tuna)	6,891,039	2,911,061
Ahi (yellowfin tuna)	1,723,128	1,463,376
Akule	746,857	422,211
Opelu	291,337	231,236
Striped marlin	230,412	113,243
Opakapaka	147,505	165,195
Ono	132,104	90,448
Mahimahi	119,332	145,010
Ulaula koae	80,543	162,219
Uku	69,832	68,321
Kahala	40,434	21,822

¹Average 5-year annual totals (1972-76) all species from commercial catches are weight: 13,259,377, value: \$6,238,927.

(Uchida 1983). Other species taken by recreational boats include rainbow runner, Elagatis bipinnulata, kawakawa, Euthynnus affinis, and amberjack, Seriola dumerili (Sands 1980).

The nearshore fisheries are dependent upon a wide array of demersal and benthopelagic species which include pink snappers, Pristipomoides filamentosus and P. sieboldii; gray snapper, Aprion virescens, red snappers, Etelis carbunculus and E. coruscans; jacks, Carangidae; goatfishes, Mulloidichthys spp. and Parupeneus spp.; and sea bass, Epinephelus quernus. Bigeye scad, Selar crumenophthalmus, and mackerel scad, Decapterus macarellus, are also major species in this group and their combined landings are second only to tuna and billfish total landings (Uchida 1983). Recreational boats also catch needlefish, Belonidae, barracuda, Syphyraena barracuda, bonefish, Albula vulpes, and leatherback, Scomberoides sancti-petri (Sands 1980).

Species of fishes taken off Kahe Point and sold commercially are listed in Table 2. The most common commercially important species of fish (those with average annual catches of >1 metric ton) include tuna, billfish, dolphin, scad, snapper, jack, and goatfish (Table 3). The catches of all species are low compared with the State landings. The skipjack tuna and dolphin catches represent 5 and 6%, respectively, of the State landings for these species. The catch of each of the other species range from 0.2 to 2.2% of the State landings. Of the important deep demersal species, such as pink, red, and gray snappers, which are among the top 11 species in the State landings, the catch by species did not exceed 400 kg per year. The total catch of these snappers off Kahe Point (729 kg) is approximately 0.5% of the State landings for this group of fishes. The low catches of all species indicate that the area off Kahe Point supports only a limited resource of fish.

2. Effects on eggs, larvae, and juveniles

a. Impingement

Impingement will depend, among other things, on the velocity of water at the intake and the swimming capability (speed and endurance) of the fish. At an intake velocity of 0.25-0.30 m/s, none of the adult pelagic fishes taken commercially in the Kahe Point area is expected to be impinged on the warmwater intake screen. Adults of some mesopelagic fishes, such as myctophids, which migrate to surface waters at night, could be impinged on the warmwater intake screen, but these fishes are not utilized commercially. Impingement of adult fish could occur at the cold-water intake screen. All fish impinged there will be small mesopelagic forms that are relatively weak swimmers. The quantity of fish impinged should be far less than 43 kg per day (Section IIIA), since many of the small adults will easily pass through the screen. Thus, there should be no immediate effect on the fisheries from impingement on either the warm or cold water intake screen.

Table 2.--Local, common, and scientific names of fishes commonly caught in Hawaii off Kahe Point (Sands 1980; Uchida 1983).

Local name	Common name	Scientific name
A'awa	Spot wrasse	<u>Bodianus bilunulatus</u>
Ahaaha	Needlefish	Belonidae (3 species)
Ahi (menpachi shibi)	Bigeye tuna	<u>Thunnus obesus</u>
Ahi (kihada)	Yellowfin tuna	<u>Thunnus albacares</u>
Aholehole	Mountain bass	<u>Kuhlia sandvicensis</u>
Aku	Skipjack tuna	<u>Katsuwonus pelamis</u>
Akule	Bigeye scad	<u>Selar crumenophthalmus</u>
Alaihi	Squirrelfish	Holocentridae
Amaama	Mullet	<u>Mugil cephalus</u>
A'u (kajiki)	Pacific blue marlin	<u>Makaira nigricans</u>
A'u (naraigi)	Striped marlin	<u>Tetrapturus audax</u>
A'u ku	Broadbill swordfish	<u>Xiphias gladius</u>
A'u (indianfish)	Shortbill spearfish	<u>Tetrapturus angustirostris</u>
A'u	Black marlin	<u>Makaira indica</u>
A'u lepe	Sailfish	<u>Istiophorus platypterus</u>
Awa	Milkfish	<u>Chanos chanos</u>
Awaawa	Tenpounder	<u>Elops hawaiiensis</u>
Aweoweo	Red bigeye	Priacanthidae
Ehu	Red snapper	<u>Etelis carbunculus</u>
Hahalalu	Small bigeye scad	<u>Selar crumenophthalmus</u>
Hanui	Parrotfish	Scaridae
Hinalea	Wrasse	Labridae
Humuhumu	Triggerfish	Balistidae
Kahala	Amberjack	<u>Seriola dumerili</u>
Kaku	Barracuda	<u>Sphyræna barracuda</u>
Kala	Surgeonfish	<u>Naso unicornis</u>
Kalikali	Pink snapper	<u>Pristipomoides sieboldii</u>
Kamanu	Rainbow runner	<u>Elagatis bipinnulatus</u>
Kawakawa	Kawakawa	<u>Euthynnus affinis</u>
Kole	Surgeonfish	<u>Ctenochaetus strigosus</u>
Kumu	Red goatfish	<u>Parupeneus porphyreus</u>
Kupoupou	Mongoosefish	<u>Cheilio inermis</u>
Laenihi	Razorfish	<u>Xyrichtys pavo</u>
Lai	Leatherback	<u>Scomberoides sancti-petri</u>
Lehi	Snapper	<u>Aphareus rutilans</u>
Mahimahi	Dolphin	<u>Coryphaena hippurus</u>
Maiii	Surgeonfish	Acanthuridae
Maiki	Surgeonfish	<u>Acanthurus nigroris</u>
Makiawa	Round herring	<u>Etrumeus micropus</u>
Malu	Goatfish	<u>Parupeneus pleurostigma</u>
Manini	Convict tang	<u>Acanthurus sandvicensis</u>
Mano kihikihi	Hammerhead shark	<u>Sphyrna lewini</u>
Maomao (mamo)	Damselfish	<u>Abudefduf abdominalis</u>
Moano	Goatfish	<u>Parapeneus multifasciatus</u>
Moi	Threadfin	<u>Polydactylus sexfilis</u>

Table 2.--Continued.

Local name	Common name	Scientific name
Moilua	Red goatfish	<u>Mulloidichthys pflugeri</u>
Mu	Porgy	<u>Monotaxis grandoculis</u>
Naenae	Orange spot tang	<u>Acanthurus olivaceus</u>
Nenue	Rudderfish	<u>Kyphosus bigibbus</u>
Nohu	Scorpionfish	<u>Scorpaenopsis cacopsis</u> and <u>S. gibbosa</u>
Nunu	Trumpetfish	<u>Aulostomus chinensis</u>
Oililepe	Filefish	<u>Alutera scripta</u>
Oio	Bonefish	<u>Albula vulpes</u>
Omaka	Jack	<u>Caranx mate</u>
Onaga	Red snapper	<u>Etelis coruscans</u>
Oopuhue	Balloonfish	<u>Arothron hispidus</u>
Opakapaka	Pink snapper	<u>Pristipomoides filamentosus</u>
Opelu	Mackerel scad	<u>Decapturus macarellus</u>
Opule	Spotted wrasse	<u>Anampses cuvieri</u>
Pakii	Flounder	<u>Bothus mancus</u> and <u>B. pantherines</u>
Palani	Surgeonfish	<u>Acanthurus dussumieri</u>
Panuhunuhu	Parrotfish	Scaridae
Panunu	Parrotfish	Scaridae
Paopao	Yellow jack	<u>Gnathanodon speciosus</u>
Pualu	Surgeonfish	<u>Acanthurus xanthopterus</u>
Puhi	Eel	Muraenidae
Saba	Japanese mackerel	<u>Scomber japonicus</u>
Taape	Blueline snapper	<u>Lutjanus kasmira</u>
Toau	Red-green snapper	<u>Lutjanus vaigiensis</u>
Uhu	Parrotfish	Scaridae
Ukikiki (gindai)	Brigham's snapper	<u>Pristipomoides zonatus</u>
Uku	Gray snapper	<u>Aprion virescens</u>
Ulaula (ehu)	Red snapper	<u>Etelis carbunculus</u>
Ulua kihikihi	Threadfin jack	<u>Alectis ciliaris</u>
Uouoa	False mullet	<u>Neomyxus chaptalii</u>
Uu (menpachi)	Squirrelfish	<u>Myripristis</u> spp.
Uukanipo	Squirrelfish	Holocentridae
Walu	Oilfish	<u>Ruvettus pretiosus</u>
Weke	Goatfish	<u>Mulloidichthys samoensis</u>
Weke ula	Red goatfish	<u>Mulloidichthys auriflamma</u>

Impingement at the warmwater intake screen will affect juveniles of epipelagic fishes, such as scombrids, billfishes, dolphins, wahoo, bonefishes, barracudas, some jacks, and some inshore fishes, such as goatfish, damselfish, filefish, squirrelfish, triggerfish, and rudderfish, which at times are found also in offshore surface waters. The smallest juveniles impinged will vary by species depending upon their body types.

Table 3.--Five-year (1976-80) mean annual catches of fish (>1 mt) taken off Kahe Point, Hawaii (Uchida 1983).

Species	Weight (kg)	Value of catch sold (in dollars)
Skipjack tuna (aku)	164,058	215,755
Yellowfin tuna (ahi)	14,899	40,490
Pacific blue marlin (a'u, kajiki)	8,106	13,533
Bigeye scad (akule)	6,887	17,422
Young bigeye scad (hahalalu)	3,435	7,798
Dolphin (mahimahi)	3,339	16,502
Striped marlin (a'u, naraigi)	2,297	4,658
Blueline snapper (taape)	1,687	1,991
Goatfish (weke)	1,371	2,134
Jack (ulua)	1,131	3,462
Red goatfish (weke-ula)	<u>1,033</u>	<u>3,057</u>
Total	208,249	326,802
Other fish	9,228	22,316
Total all fish	217,477	349,118

Among the slender bodied fish, those with body length to depth ratio of about 3:1 (scombrids, billfishes, dolphins, wahoo, barracudas, some jacks, goatfishes, etc.), impingement could occur at sizes as small as 4 cm. Others, juveniles with deeper bodies (some jacks, surgeonfish, squirrelfish, damselfish, etc.), could be impinged at even smaller sizes, perhaps around 2 cm. At these sizes, most juveniles will not be strong enough swimmers to escape impingement. Although juveniles of such fishes as the tunas are considered strong swimmers, no studies have yet been made to measure their swimming ability. One study of a closely related fish, Pacific mackerel, has been made (Hunter 1980) which shows that juveniles up to 3.6 cm long can swim at burst speeds of 26 cm/s. At this speed, which is within the range of the intake velocity, the juveniles would be able to barely maintain their position at the intake opening. Any juvenile caught in this position will eventually become impinged as fatigue sets in. Juveniles 4.0 cm long may suffer the same fate.

There are no published data on swimming speeds of larger juveniles, nor of the density of such juveniles off Kahe Point. Although juvenile tunas have been caught off Kahe Point in midwater trawls (Higgins 1970), all juveniles, with the exception of one 47-cm specimen, were smaller than 23 cm. Consequently, these will be considered together with the larvae. Juveniles of other species were not analyzed.

Although it can be assumed that all juveniles impinged on the screen will suffer mortality, the maximum size of juveniles that would be impinged

has not been determined. Thus, estimates of losses due to impingement cannot be made.

b. Primary entrainment

Effects of primary entrainment on fish eggs and larvae of most commercially important fish species off Kahe Point are difficult to assess, owing to the absence of adequate vertical distribution and density data. The study by Miller et al. (1979) is the only one in which fish larvae have been identified to family or lower levels. However, because sampling was limited to shallow inshore waters, their results may have only limited application for assessing the kinds and density of larvae in the projected OTEC plantsite off Kahe Point. Miller et al. (1979) sampled off Kahe Point at 0.1-0.2 nmi from shore in 3-5 m of water ("inshore" stations) and at about 0.8 nmi in 27-128 m ("offshore" stations). The list of larvae identified (Table 4) includes five species (Chanos chanos, Coryphaena hippurus, Abudefduf abdominalis, Thunnus albacares, and Euthynnus affinis) and larvae of five other families (Kyphosidae, Labridae, Mullidae, Scorpaenidae, and Tetraodontidae) which are utilized commercially. It also includes 31 species (including 13 unidentified types of gobies) that are not utilized commercially. Approximately 90+ species utilized commercially were not taken in their plankton tows.

In another study which included intensive sampling off Kahe Point at approximately 0.2-0.6 nmi from shore, Miller (1979) obtained a mean abundance of 7.7/1,000 m³ of tuna larvae in daytime surface tows and as high as 441/1,000 m³ of yellowfin tuna in night tows, the latter being one to two orders of magnitude higher than the average open ocean densities. Miller hypothesized that the high nearshore density of tuna larvae probably was the result of nearshore upwelling accompanied by an onshore movement of deeper waters. Whatever the cause of the concentration of yellowfin tuna larvae at Kahe Point, the extremely high density reported by Miller is most likely a local phenomenon and is not representative of offshore waters. In open ocean sampling for tuna larvae in Hawaiian waters (unpublished data, Honolulu Laboratory) skipjack tuna larvae dominated the catches of tuna larvae in surface tows. The density of skipjack tuna larvae was 3.02/1,000 m³ and that of yellowfin tuna larvae was 1.47/1,000 m³.

The density of skipjack and yellowfin tuna larvae in open ocean waters obtained from plankton nets compares favorably with the density estimates of juvenile tunas obtained by Higgins (1970). Higgins used a midwater trawl consisting of 1.9-cm mesh netting and a mouth opening of 96 m². The net had a cod end liner made of 0.63-cm mesh netting and an opening of 7.5 m². Tows were made at two sites off Oahu (the inshore stations were 1.4 km north of Kahe Point), 7 and 56 km from shore, in the vicinity of the projected OTEC plantsite. The catch included skipjack and yellowfin tunas ranging in size from 7 to 26 mm, and one juvenile skipjack tuna 47 mm long. The density of young skipjack tuna was 2.4/1,000 m³ and that of yellowfin tuna was 0.74/1,000 m³. The densities of both species are somewhat underestimated since many larvae below 8 or 9 mm were suspected of having passed through the 0.63-cm netting.

Table 4.--Fish larvae taken off Kahe Point in plankton net tows
(larvae/1,000 m³ (Miller et al. 1979).

Family	Species	Inshore		Offshore	
		Winter	Summer	Winter	Summer
Dussumieriidae	<u>Spratelloides delicatulus</u>	--	--	--	--
Engraulidae	<u>Stolephorus buccaneeri</u>	----- (Several specimens) -----			
Chanidae	<u>Chanos chanos</u>	----- (Never abundant) -----			
Gonostomatidae	<u>Cyclothone</u> sp.	1.8	11.0	0.9	0
	<u>Vinciguerrria nimbaria</u>	6.1	4.4	0	0
Myctophidae	<u>Ceratoscopelus warmingi</u>	0	5.7	0.9	1.4
	<u>Hygophum proximum</u>	1.8	0	0	0
	<u>Lampadena</u> spp.	0	0.7	0.9	0
Exocoetidae	<u>Cypselurus</u> spp.	1	1.5	0	0.7
Atherinidae	<u>Pranesus insularum</u>	----- (1 larva per tow) -----			
Kyphosidae ¹	--	--- (Several larvae in July) ---			
Mullidae ¹	--	0	16.2	0	8.1
Serranidae	--	----- (Some) -----			
Coryphaenidae ¹	<u>Coryphaena hippurus</u>	21.1	0	0	0
Pomacentridae ¹	<u>Abudefduf abdominalis</u>	5.3	3.7	2.8	37.0
	<u>Eupomacentrus fasciolatus</u>	6.1	0.7	0	0
Labridae ¹	Labrid L-3	----- (1 larva) -----			
Scombrolabracidae	<u>Scombrolabrax heterolepis</u>	- (Some larvae in fall-winter) -			
Scombridae ¹	<u>Auxis</u> sp.	0	0	0	0.7
	<u>Thunnus albacares</u>	0	1.3	0	0
	<u>Euthynnus affinis</u>	----- (At two stations) -----			
Gobiidae	13 types	0	0	2.8	0.7
	<u>Psilogobius mainlandi</u>	0	2.1	0	0
Tripterygiidae	--	8.7	4.0	0.8	0
Blenniidae	<u>Enchelyurus brunneolus</u>	0	20.2	1.9	36.0
	<u>Exallias brevis</u>	0	46.0	1.0	11.4
Schindleriidae	<u>Schindleria pietchmanni</u>	0.9	1.3	0	0
Scorpaenidae ¹	Scorpaenid S-3	Few	Few	Few	Few
Tetraodontidae ¹	--	0	2.2	0	0.7
Molidae	<u>Ranzania laevis</u>	----- (Few in spring) -----			

¹Adults caught commercially.

Because the size range of larvae taken in plankton nets complements that of larvae and juveniles taken in midwater trawl, the densities derived from both gear should provide rough estimates of the numbers of young tunas that could be entrained in the warmwater intake. Thus, based on the combined density of 5.42/1,000 m³ for skipjack tuna and 2.21/1,000 m³ for yellowfin tuna, and on the volume of water passing through the plant each day (13.8 million m³), roughly 75,000 skipjack and 30,000 yellowfin tuna larvae

and juveniles could be entrained daily. Since tunas spawn from late spring to early autumn in Hawaiian waters (about 6 months), roughly 13.7 million skipjack and 5.5 million yellowfin tuna larvae and juveniles could be entrained in the warmwater intake seasonally (= annually).

Entrainment estimates can be made for billfishes also. Using the density value of $0.579/1,000 \text{ m}^3$ for billfishes (Pacific blue marlin, sailfish, and shortbill spearfish) in Hawaiian waters (Matsumoto and Kazama 1974), the daily entrainment could be about 8,000. The annual entrainment could be about 1.4 million since spawning extends from May through October.

Estimates of entrainment of larvae of other commercially important fishes cannot be made due to the lack of information on the identity and density of many bottom-associated as well as pelagic species.

Free floating fish eggs in the ocean are concentrated near the surface, and the density of eggs decreases sharply with depth. Catch data from oblique plankton net tows made off Kahe Point (Noda et al. 1981) indicate that about 72% of the eggs (all species) were in the upper 25 m, 24% in the 25-200 m depth range and 4% in the 200-1,000 m depth range. The density of eggs in the top 1 m of water (based on neuston net catches) was nearly twice the average for the 0-25 m depth layer ($213,000/1,000 \text{ m}^3$ vs. $117,000/1,000 \text{ m}^3$). Because the distribution of eggs is skewed toward the surface and the intake is located in the lower half of the 0-25 m depth layer, the density of eggs at the intake level should be well below a third ($<39,000/1,000 \text{ m}^3$) that of the depth layer. Based on the 13.8 million m^3 of water expected to be drawn into the plant each day, the number of eggs entrained daily could be about 538 million.

The impact on the fishery resulting from the loss of this many eggs cannot be measured accurately, since the eggs had not been identified and quantified by species. Nevertheless, in view of the tremendous spawning capacity of some of the pelagic fishes [e.g., yellowfin tuna, 2-8 million (June 1953); skipjack tuna, 100,000-2 million (Matsumoto et al. in press); kawakawa, presumably similar to skipjack tuna; striped marlin, 2-28 million (Ueyanagi and Wares 1975); blue marlin, presumably similar to striped marlin; sailfish 2-20 million (Beardsley et al. 1975); shortbill spearfish, 2-6 million (Kikawa 1975)], and the expected losses representing only a minor portion of the total eggs in the area, the projected egg losses due to OTEC plant operations should have no drastic effects on the fishery.

In summary, biocides used in strong enough concentration to kill biofouling organisms could also kill fish eggs and larvae; however, because the EPA restricts the discharge of chlorine to 2 h each day, the mortality from this source should be limited. Total or near total mortality of eggs and larvae and up to 68% mortality of entrained juveniles could occur from thermal effects and physical damages suffered during passage through the pumps, and from collision with structures and other organisms. Larvae and juveniles surviving through the discharge will be physically weak and be especially susceptible to predation. Consequently, the assumption of total mortality of all fish eggs, larvae, and juveniles entrained is not unreasonable.

In a worst case situation, assuming 100% mortality of the young, exclusive of eggs, the losses from primary entrainment of the three most important fishes or fish groups taken off Kahe Point would be 13.7 million skipjack tuna, 5.5 million yellowfin tuna, and 1.4 million billfishes per year. The damage to other pelagic and demersal fishes caught commercially cannot be determined until their eggs and larvae are identified and density estimates are obtained.

c. Secondary entrainment

Damage to fish eggs and larvae entrapped in the discharge could result mainly from thermal shock and the impact and turbulence of the discharged water. Although the number of larvae affected could be large, due to the magnitude of the discharge volume, an accurate assessment cannot be made without more detailed data on the distribution of eggs and larvae near the discharge depth, the strength of the impact, the intensity of acceleration and shear forces in the eddies, and the timespan these forces will be acting upon the eggs and larvae at lethal levels. Available data only permit very rough estimates.

Eggs and larvae of tunas and marlins generally occupy the surface and near surface waters. Only a small fraction is found in depths greater than 60 m (Matsumoto 1958; Strasburg 1960; Matsumoto and Kazama 1974). Strasburg (1960) estimated that 75-80% of the tuna larvae in the central Pacific equatorial waters occurred in the 0-60 m depth range, 20-25% in 70-130 m, and none in depths greater than 130 m. Assuming a similar vertical distribution in Hawaiian waters, about 2.7-3.4 million skipjack tuna and 1.1-1.4 million yellowfin tuna larvae could be entrained in the discharge each year.

Larvae of other fishes utilized commercially off Kahe Point, such as dolphin, jacks, and goatfish, also may be concentrated near the surface, since their eggs are buoyant. Very little is known about the eggs and larvae of snappers; however, a study by Kikkawa (1980) on the spawning season of the pink snapper, Pristipomoides filamentosus, indicates that ripe eggs of this species contain oil globules. Eggs of other species of snappers would most likely contain oil globules also. Such eggs are buoyant and, therefore, would be concentrated near the surface, similar to eggs of tunas, marlins, dolphins, and jacks. Consequently, the hatched larvae would likewise be concentrated near the surface. Larvae of those species mentioned above would be sparsely distributed near the discharge depth so that even at 100% mortality during secondary entrainment, the negative effects to the fishery should be minimal.

d. Effects by all categories

Because the eggs of most fishes caught commercially off Kahe Point are buoyant, and eggs and larvae are concentrated near the surface, most of the damage will occur during primary entrainment. Eggs and larvae could suffer total mortality, so that larvae of approximately 13.7 million skipjack tuna, 5.5 million yellowfin tuna, 1.4 million billfish, and an unknown quantity of other pelagic, reef-associated, and demersal fishes

could be killed each year. Damage from secondary entrainment could account for an additional 3.4 million skipjack and 1.4 million yellowfin tuna larvae. Other losses could occur from impingement of juveniles at the warm intake screen. Because of their strong swimming capability, however, kills from impingement are expected to be small for tunas. Juveniles of slow swimming reef and bottom fishes, however, could be affected more seriously. No estimate of potential damage to juveniles from impingement can be made at this time.

Although the total damage to all commercially important fishes off Kahe Point cannot be assessed accurately, rough estimates of damages from primary and secondary entrainment can be made for the two groups of fishes that together contribute 87.5% of the commercial catch off Kahe Point. Thus, at least 17.1 million skipjack tuna, 6.9 million yellowfin tuna, and 1.4 million billfish larvae could be killed annually, assuming the worst condition.

3. Effects of attraction

Studies of fish aggregating devices (FADs) show that large build up of fish schools can occur around objects floating in the ocean (Matsumoto et al. 1981). Although most fish attracted to the FADs are small, i.e., juveniles and preadults which tend to be longer term dwellers, large fish also congregate temporarily. Similar build up of fish schools can occur also around stationary objects such as the OTEC plant (Seki 1983). The attraction of fish schools could be of considerable benefit to recreational and commercial fishermen by enabling them to increase catches, while at the same time reducing fuel consumption.

There are some negative effects to attraction, particularly by an OTEC plant. With the accumulation of large fish around the plant, spawning will eventually take place as the fish mature sexually during the season. This will increase the density of eggs and larvae around the plant and ultimately result in raising the number of larvae killed by entrainment. The discharge plume also could attract fish that could prey upon larvae and juveniles that are damaged and weakened by the impact and turbulence of the effluent. The predation level thus could rise and increase the mortality of larvae and juveniles.

4. Effects on recruitment

The effects of egg and larval mortality from OTEC plant operations on the recruitment of fish into the fishery will vary greatly by species. For such fish as the tunas and billfishes, which are highly migratory and spawn widely throughout the tropical and subtropical waters, egg and larval mortality at isolated points, such as around OTEC plants, will have little or no impact on the adult population at the plantsite. This is based on the following observations. First, a large proportion (50-90%) of the adults that comprise the skipjack tuna fishery in Hawaii are 60 cm or larger (Rothschild 1965). These fish are migrants, some arriving from the eastern Pacific northern fishery, a portion from the northwestern Pacific, and others from equatorial waters to the south (Matsumoto et al. in press).

It is generally accepted that these fish originate largely from spawnings in equatorial waters and consequently, egg and larval mortality at the Kahe Point site will have little influence on the size of the adult population there. Second, a portion of the skipjack tuna below 60 cm, representing age group 1-1+, could originate in Hawaiian waters, since there is ample evidence of the presence of small (30-37 cm) fish there throughout the winter months (Matsumoto et al. 1981). The effects of egg and larval mortality off Kahe Point, however, may not be noticeable in this age group because larvae originating there do not necessarily return to that particular site. Instead the return is made to Hawaiian waters in general. Moreover, as in the larger size group, some of the fish migrate from the south as seasonal warming moves northward. Third, most of the eggs and larvae that are expected to be killed by OTEC plant operation would have died eventually from natural causes. Hence the actual kill due solely to OTEC plant operations would be the estimated total minus the losses expected from natural mortality.

Natural mortality rates (M) of eggs and larvae of tunas have not been determined precisely, but published estimates of M for tunas taken in various fisheries have been reviewed by Murphy and Sakagawa (1977). They indicate that the range of M is 0.67-0.91 for yellowfin tuna and 0.69-0.93 for skipjack tuna, and the mean for both species is approximately 0.8. Since M is greatly underestimated for larvae and juveniles, it would be reasonable to use the higher M for both species. The net losses due to OTEC plant operations thus would be approximately 1.2 million skipjack tuna and 0.6 million yellowfin tuna.

For other fish, such as reef and deep demersal types, the effect on recruitment cannot be measured until eggs and larvae have been identified and more complete information about their biology and ecology has been obtained.

5. Recent developments

The discussion above was based on OTEC plant placement between 1 and 2 mi offshore, and the discharge located at a depth of about 100 m and well away from the bottom. Recent development in planning indicates that the plant could be located within 1 mi from shore at a depth of 50 m. The discharge is to be led through a pipe to the 100-m ledge, and released in a downward trajectory over the escarpment, where the depth drops off from 100 to 900 m over a distance of 4.6 km. The warmwater intake facing shoreward at the plantsite will have a mouth opening 20 m wide and 30 m deep so that it will be 10 m below the surface and 10 m off the bottom. In addition to the surface water, warm effluent from the existing electric powerplant will be utilized to heat the working fluid. This powerplant effluent contains some sand, which eventually will be discharged in the OTEC plant effluent. The sedimentation caused by the effluent thus will be a new element affecting the environment near the discharge point.

There should be little change in the eggs and larvae entrained in the warmwater intake system, but major changes could occur to the bottom fauna below the discharge point. There will be a buildup of sand on the

escarpment which could change the habitat from rocky to sandy bottom of choice market fish, such as the snappers. These fish, which occupy a depth range of 70 to 300 m (Ralston 1980), thus could be driven off the discharge area. Although the immediate effects may not be severe, the affected area could become extensive over time and eventually drive out these fish from large tracts of bottom.

B. Puerto Rico

1. Fisheries

The fishery in Puerto Rico is largely an inshore fishery which in 1978 produced 2.5 million kg of finfish (Weiler and Suarez-Caabro 1980). Fishing is done from small boats, usually <7.6 m (25 ft) long, and with gear requiring few men. In 1978 the highest production was from fish pots (53.3%), followed in order by handline (20.7%), troll (8.7%), gill net (8.2%), beach seine (7.7%), and others (1.4%); and the production, by coast were: west (46%), south (25%), east (20%), and north (9%).

On the east coast, where the OTEC plant will be located, the principal fishes taken are various species of groupers (Serranidae) 25%, grunts (Pomadasyidae) 19%, and snappers (Lutjanidae) 18%. Other fishes taken in much smaller quantities are mackerels (Scomberomorus) 6%, goatfish (Mullidae) 5%, triggerfish (Balistidae) 5%, and porgy (Sparidae) 4%. The remainder, which includes trunkfish (Ostraciidae), wrasse (Labridae), parrotfish (Scaridae), barracuda (Sphyranidae), tunas (Scombridae), jacks (Carangidae), mullet (Mugilidae), and half-beak (Hemiramphidae), account for 18% of the production.

2. Effects on fisheries

The effects on fisheries off Punta Tuna on the east coast would be similar to those off Kahe Point, Hawaii. Eggs and larvae of pelagic fishes, such as tunas, billfishes, mackerels, some jacks, and some demersal fishes with buoyant eggs, such as snappers, will be minimally affected by OTEC plant operation. As in Hawaii, very little is known about the biology of most reef- and bottom-dwelling forms. Consequently, the extent of damage to eggs and larvae of these fishes cannot be estimated. Some minor changes could occur to the environment inhabited by the adults of the three most important fishes. Groupers, grunts, and snappers normally are found in depths ranging from 75 to 290 m in Hawaii. If these fishes occur in similar depths off Puerto Rico, they would most likely be found in water ranging from 23° to 13.5°C. Since the discharge temperature is 15.5°C water at a depth around 100 m, there would be a lowering of the habitat temperature by about 8°C or less. This could force the groupers, and perhaps the porgies also, to move away from the site of the outfall.

Indirect effects could occur from increased primary production at the discharge depth. Whether this will be beneficial or detrimental to the demersal fish species has yet to be determined.

V. SUMMARY AND CONCLUSION

This document presents a review of pertinent operating conditions of a 40 MW OTEC pilot plant presently being planned for sites off Kahe Point, Hawaii, and Punta Tuna, Puerto Rico, the factors that may affect the fisheries, and the fisheries affected at the two sites.

At Kahe Point, the probable plantsite will be slightly <1 mi from shore at a depth of 50 m. The warmwater intake will be at a depth of 10-30 m and the cold water intake at a depth of 800-900 m. The mixed water will be discharged at a depth of 100 m in a downward trajectory over an escarpment where the depth drops from 100 to 900 m over a distance of 4.6 km.

The flow rate for the warmwater intake will be about $4 \text{ m}^3/\text{s}/\text{MW}$ or roughly 13.8 million m^3/day for a 40 MW plant. A similar flow rate is expected in the cold water intake.

The plant operation is expected to affect the fisheries in several ways: large juveniles and small, weak-swimming adults will be impinged on the intake screen; eggs and larvae and small juveniles capable of passing through the intake screen will be entrained and exposed to sudden changes in temperature, biocides, and physical damage; and eggs and larvae would be exposed to these same factors in the discharge plume.

As in existing powerplant operations, physical stresses inflicted upon fish eggs and larvae during passage through the OTEC plant will be the major cause of damage. Mortality from these causes could be high (up to 100%), whereas, mortality due to biocide treatment and rapid changes in temperature could be negligible.

The principal fisheries off Kahe Point that would be affected by OTEC plant operations include those of six pelagic and two demersal fish groups representing 98% of the area's total annual production. The pelagic forms include: tuna (mainly skipjack and yellowfin), billfish (Pacific blue and striped marlin), dolphin, wahoo, bonefish, and jacks (principally scad). The demersal forms include goatfish (six species) and snappers (eight species).

Based on density values of tuna and billfish larvae at depths near the warm intake and discharge points, rough estimates of the extent of damage from plant operations can be made. Assuming total mortality during entrainment, 17.1 million skipjack and 6.9 million yellowfin tuna larvae could be killed each spawning season. Adjusting these values to reflect losses due to natural mortality (assuming M of 0.93 for skipjack tuna and 0.91 for yellowfin tuna), the net loss due strictly to plant operations would be approximately 1.2 million skipjack and 0.6 million yellowfin tuna larvae. Calculations for billfish larvae yields an estimate of 1.4 million killed per season. The net loss due to plant operations cannot be estimated since M is not known for these species. Estimates of damages to other fish larvae in the Kahe Point area cannot be made due to lack of pertinent information.

The OTEC plant is expected to function as a FAD and attract fish from adjacent areas. Any build up of large aggregations of fishes, such as tunas, dolphins, mackerels, and carangids will eventually result in concentrated spawnings around the plant, subjecting more than the usual amounts of eggs and larvae to entrainment effects.

Effects of OTEC plant operations on the fisheries will be largely through the recruitment process. The effects of recruitment on pelagic species, particularly tunas, will not be noticeable because most of them are migrants from the eastern Pacific fishery, the northwestern Pacific, and from equatorial waters. The effects of recruitment on bottom and reef-associated fishes would most likely be felt in areas farther downstream from the plantsite. Because the prevailing currents carry the eggs and larvae along the coast and out into open ocean, the full impact of the damages caused by the plant may not be apparent at the plantsite.

Direct effects could occur in the demersal fishery. If the warm effluent from the existing powerplant is also used to heat the working fluid, the sand particles contained in this effluent will eventually be discharged over the escarpment. The sand particles could build up and, over a period of time, blanket the rocky bottom near the discharge point and thus force such species as the snappers, groupers, and grunts to relocate in other areas. The net effect to the fishery should be negligible, however, since these species comprise only a small portion (1.3%) of the total fish production off Kahe Point.

The principal fisheries off Punta Tuna include four demersal and one pelagic fish group representing 72% of the fish taken along the eastern coastline. The demersal group includes: groupers (14 species), grunts (11 species), snappers (14 species), and porgies (3 species); and the pelagic group is composed of mackerels (2 species). Other pelagic fishes, such as tunas, marlins, dolphins, and jacks, comprising 1.8% of the total fish production, are caught in small numbers.

The effects of OTEC plant operations on pelagic fishes off Punta Tuna will be insignificant. The effects on demersal and reef fishes cannot be estimated in the absence of appropriate data and biological information.

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A

INTRA-ATOLL RESIGHTINGS OF THE HAWAIIAN MONK SEAL

MONACHUS SCHAUINSLANDI

AT

FRENCH FRIGATE SHOALS

1 JANUARY 1983 - 31 AUGUST 1983

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FINAL DRAFT
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PREFACE

This report was prepared under contract No. 41 USC 252 (C) (3) to the National Marine Fisheries Service by Gale W. Fairaizl. The primary purpose of the contract was to continue monitoring movements and reproductive patterns of individually identifiable Hawaiian monk seals at French Frigate Shoals. The statements and findings in this report are those of the contractor and do not necessarily reflect the view of the National Marine Fisheries Service.

William G. Gilmartin
Leader, Marine Mammals and
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INTRODUCTION

A large breeding population of the endangered Hawaiian monk seal, Monachus schauinslandi, is found at French Frigate Shoals (FFS). FFS is a crescent shaped atoll which lies midway in the Hawaiian archipelago and is located at lat. 23 45'N, long. 166 10'W. FFS, which consists of a large volcanic pinnacle and 12 small sandy islets, was designated a breeding bird preserve by President Theodore Roosevelt in 1909 and became part of the Hawaiian Islands National Wildlife Refuge (HINWR) in 1940.

FFS was initially inhabited during WWII by the Navy who enlarged one of the islets, Tern Island, from 11-37 acres to accomodate an airstrip. The Coast Guard established a LORAN Station on East Island in 1944 and moved to Tern Island in 1952 where the station was maintained until 1979. The station was decommissioned in July 1979 and two U.S. Fish & Wildlife Service (FWS) refuge managers and their spouses replaced the 20 Coast Guard personnel. FWS acquired Tern Island for the purpose of performing research and assisting other agencies in research projects while agreeing to maintain the facilities.

A long term research project on the Hawaiian monk seal was initiated at FFS in July of 1979. The purpose of this report is to present and summarize the sightings of intraatoll movements of individually identified monk seals from the period of 1 January 1983 to 31 August 1983.

METHODS

Sightings of intraatoll movements of individually identified Hawaiian

monk seals were recorded on data sheets. Seals were individually identified by obvious natural bleach marks or scars. A seal was considered individually identified or "known" by the presence of a bleach mark or scar(s) that were obvious to all observers or by a rear flipper tag.

Known seals were assigned an identification number (I.D.#) and photographs of those identifying marks were taken. An attempt was made to photograph the seals' ventral, dorsal, left and right sides as these help to further identify and confirm sightings of individual seals. The photographs were subsequently placed in photo albums that were categorized by age and sex. The photographs were updated opportunistically to document fresh wounds or any other physical change. Sketches or "scar cards" were often drawn up to further aid in identification.

Individual files were established for all seals with I.D.#'s where the date, age, island, sector, molt, association, behavior and pup status were recorded for each resighting as well as any other incidental observations.

Deceased known seals and known seals without recent resightings and good photographs for identification were placed in inactive files. Their I.D.#'s were not reassigned to avoid confusing their histories with those of other seals. Known seals which have good recognizable marks but no recent sightings were kept in the active files.

Data on the intraatoll movements of the monk seal were collected from a 4 day interval seal survey on Tern Island and a 36 day interval atoll survey using the techniques reported by Ittner, 1982. As a result, Tern was surveyed more frequently and the seals received closer scrutiny than the seals on outer islets. A new survey form was introduced by

National Marine Fisheries Service (NMFS) on 17 April 1983 which required additional information on age classes and behavior. Additional data on intraatoll movements were collected by the NMFS field camps that were set up on East and Whale-Skate Islands from May to mid-August, 1983. The primary objective of these field camps was to collect pupping data on adult female seals and identify mother-pup pairs.

RESULTS AND DISCUSSION

Upon completion of this study, there were a total of 253 known seals at FFS. There were 83 adult males (AM), 108 adult females (AF), 15 subadult males (SM), 17 subadult females (SF), 13 juvenile males (JM), 15 juvenile females (JF), and 3 seals of unknown age and sex.

Twenty seals were added to the active files during this study period (Table 1).

Table 1. Seals Added To The Active Files.

	AM	AF	SM	SF	JM	JF
I.D.#	254	253	267	265	125	-
	256	255	-	268	258	-
	263	257	-	-	-	-
	270	260	-	-	-	-
	-	261	-	-	-	-
	-	262	-	-	-	-
	-	264	-	-	-	-
	-	266	-	-	-	-
	-	269	-	-	-	-
	-	271	-	-	-	-
	-	272	-	-	-	-

Eighteen seals were placed in inactive files (Table 2).

Table 2. Known Seals Placed In The Inactive Files.

I.D.#	AM	AF	A? ¹	SM	SF	S?	JM	JF	J?	p ²
204	202	163	-	-	-	124	187	189	68	12
105	85	-	-	-	-	-	98	174	-	-
-	35	-	-	-	-	-	-	80*	-	-
-	198	-	-	-	-	-	-	-	-	-
-	236	-	-	-	-	-	-	-	-	-
-	155	-	-	-	-	-	-	-	-	-
-	21	-	-	-	-	-	-	-	-	-

¹ unknown sex

² pup

* deceased

Twenty seals were kept in the active files but have not been resighted for the past 1 to 3 years (Table 3).

Table 3. Seals Kept in the Active Files but no Recent Resightings.

I.D.#	AM	AF	A?	SM	SF	S?	JM	JF	J?
194	176	-	95	51	167	-	-	126	93
179	66	-	-	-	166	-	-	117	-
193	113	-	-	-	-	-	-	92	-
192	197	-	-	-	-	-	-	-	-
127	123	-	-	-	-	-	-	-	-
-	90	-	-	-	-	-	-	-	-

Close scrutiny of the active files revealed the presence of several duplicates. As a result 8 AF's were combined into 4 (Table 4).

Table 4. Duplicate I.D.#'s Combined.

AF I.D.#185 and AF I.D.#198
59 236
67 155
34 21

I.D.#'s 198, 236, 155, and 21 were removed from the active files.

Table 5. Intraatoll Sightings of Known Adult Males at FFS.

[illegible]

Table 5 con't.

AM I.D.#	Tern	Trig	East	WS	RO	MU	Shark	Dis	Gins	Bare
121	*	-	-	-	-	-	-	-	-	-
129	*	-	-	-	-	-	-	-	-	-
130	*	-	-	-	-	-	-	-	-	-
131	*	-	-	-	-	-	-	-	-	-
133	*	-	-	-	-	-	-	-	-	-
134	*	-	-	-	-	-	-	-	-	-
136	*	-	-	-	-	-	-	-	-	-
139	*	-	-	-	-	-	-	-	-	-
142	*	-	-	-	-	-	-	-	-	-
143	*	-	-	-	-	-	-	-	-	-
153	*	-	-	-	-	-	-	-	-	-
161	*	-	-	-	-	-	-	-	-	-
165	*	-	-	-	-	-	-	-	-	-
168	*	*	-	-	-	-	-	-	-	-
183	-	-	-	*	-	-	-	-	-	-
184	-	-	-	*	-	-	-	-	-	-
188	*	-	-	-	-	-	-	-	-	-
191	*	-	-	-	-	-	-	-	-	-
196	?	-	-	-	-	-	-	-	-	-
215	*	-	-	*	-	-	-	-	-	-
219	*	-	-	-	-	-	-	-	-	-
242	*	-	-	*	-	-	-	-	-	-
249	*	-	-	-	-	-	-	-	-	-
250	*	-	-	-	-	-	-	-	-	-
254	*	-	-	*	-	-	-	-	-	-
256	*	-	-	-	-	-	-	-	-	-
258	*	-	-	-	-	-	-	-	-	-
259	*	-	-	-	-	-	*	-	-	-
263	-	-	*	-	-	-	-	-	-	-
270	*	-	*	-	-	-	-	-	-	-

Table 6. Intraatoll Sightings of Known Adult Females in FFS

AF I.D.#	Tern	Trig	East	WS	RO	MU	Shark	Dis	Gins	Bare
4	*	*	*	-	-	-	-	-	-	-
8	-	-	*	-	-	-	-	-	-	-
9	*	-	*	-	-	-	-	-	-	-
10	*	-	*	*	-	-	-	-	-	-
11	-	-	-	*	-	-	-	-	-	-
14	*	-	*	-	-	-	-	-	-	-
19	*	-	-	-	-	-	-	-	-	-
26	*	-	-	-	-	-	-	-	-	-
27	*	-	-	-	-	-	-	-	-	-
29	*	-	*	-	-	-	-	-	-	-
33	*	-	-	-	-	-	-	-	-	-
46	*	-	*	-	-	-	-	-	-	-

Table 6 con't.

AF I.D#	Tern	Trig	Fast	WS	RO	MU	Shark	Dis	Gins	Bare
56	*	-	*	*	-	-	-	-	-	-
59	-	-	-	*	-	-	-	-	-	-
63	*	-	*	-	-	-	-	-	-	-
65	-	-	-	*	-	-	-	-	-	-
67	-	-	-	*	-	-	-	-	-	-
69	*	-	-	-	-	-	-	-	-	-
70	*	-	*	-	-	-	-	-	-	-
72	*	-	-	*	-	-	-	-	-	-
78	*	-	-	-	-	*	-	-	-	-
84	-	-	-	*	-	-	-	-	-	-
87	-	-	-	?	-	-	-	-	-	-
94	*	-	-	*	-	-	-	-	-	-
103	*	-	-	*	-	-	-	-	-	-
107	*	-	-	-	-	-	-	-	-	-
110	*	-	-	-	-	-	-	-	-	-
128	*	*	-	*	-	-	-	-	-	-
135	-	-	*	*	-	-	-	-	-	-
140	*	-	-	-	-	-	-	-	-	-
144	?	-	-	-	-	-	-	-	-	-
145	*	-	-	-	-	-	-	-	-	-
149	-	-	*	-	-	-	-	-	-	-
150	*	-	-	*	-	-	-	-	-	-
159	*	-	-	-	-	-	-	-	-	-
164	-	-	*	-	-	-	-	-	-	-
171	-	-	-	*	-	-	-	-	-	-
173	-	-	*	-	-	-	-	-	-	-
178	*	-	-	-	-	-	-	-	-	-
180	*	-	*	-	-	-	-	-	-	-
190	-	-	-	*	-	-	-	-	-	-
199	-	-	-	*	-	-	-	-	-	-
203	-	-	*	-	-	-	-	-	-	-
206	-	-	-	*	-	-	-	-	-	-
209	-	-	*	-	-	-	-	-	-	-
210	-	-	*	-	-	-	-	-	-	-
212	-	-	*	-	-	-	-	-	-	-
218	-	-	*	-	-	-	-	-	-	-
220	-	-	*	-	-	-	-	-	-	-
221	-	-	*	-	-	-	-	-	-	-
223	*	-	*	-	-	-	-	-	-	-
226	-	-	-	*	-	-	-	-	-	-
227	*	-	-	*	-	-	-	-	-	-
228	-	*	-	*	*	-	-	-	-	-
232	-	-	-	*	-	-	-	-	-	-
233	-	-	?	-	-	-	-	-	-	-
234	*	-	-	-	-	-	-	-	-	-
235	-	-	-	*	-	-	-	-	-	-
243	-	-	-	?	-	-	-	-	-	-
251	-	-	-	*	-	-	-	-	-	-

Table 9 cont.

JM I.D.#	Tern	Trig	East	WS	RO	MU	Shark	Dis	Gins	Bare
45	*	-	*	-	-	-	-	-	-	-
86	-	-	-	*	-	-	-	-	-	-
112	*	-	-	*	-	-	-	-	-	-
125	*	-	-	-	-	-	-	-	-	-

Table 10. Intraatoll Sightings of Known Juvenile Females in FFS

JF I.D.#	Tern	Trig	East	WS	RO	MU	Shark	Dis	Gins	Bare
101	*	-	*	-	-	-	-	-	-	-
147	*	-	-	-	-	-	-	-	-	-
181	*	-	*	-	-	-	-	-	-	-
211	*	-	-	-	-	-	-	-	-	-
252	*	-	-	-	-	-	-	-	-	-

?=not a confirmed sighting

Nearly twice as many known AM's were resighted on Tern than known AF's (Table 11). This may be explained by the fact that AM's tend to "cruise" around all islands, and AF's spend more time on other islands during pupping season.

Table 11. Resightings of Known Seals in FFS.

	Total # of Known Seals	# Known Seals Resighted on Tern	# Known Seals Re- sighted on Other Islands	% Resightings Known Seals FFS
AM	83	57	5	75
AF	107	33	37	65
SM	15	9	1	66
SF	17	7	4	65
JM	13	4	1	38
JF	15	5	0	33

RESIGHTINGS OF TAGGED SEALS

Approximately 305 seal pups were tagged in the folds of their rear flippers between the years of 1966 and 1972 at FFS (Peiterson, pers. comm.) (Table 12).

Table 12. Tagging at French Frigate Shoals

<u>Number Tagged at FFS</u>	<u>Year</u>
10.....	1966
46.....	1967
68.....	1968
47.....	1969
54.....	1970
41.....	1971
39.....	1972
305	

Eleven tagged seals were resighted on 35 different occasions from July 1979 through December 1981 (Schulmeister 1982) and 12 tagged seals were resighted 67 times from 1 January to December 1982 (Ittner 1982). A total of 13 tagged seals, 6 AM's and 7 AF's, were resighted on 41 different occasions during this study period. Four of the tagged AF's, I.D.#'s 59, 150, 171 and 218, pupped this year. Resightings of tagged AF's with nursing pups were recorded only once during the 1983 pupping season, as daily recordings would have artificially inflated the number of tagged seals (Table 13).

Table 13. Resightings of Tagged Seals.

<u>Sex & I.D.#</u>	<u>Age</u>	<u>Year Tagged</u>	<u>Island Tagged</u>	<u>Tag No.</u>	<u>Island-Resighting</u>
AF#59	11	1972	Tern	A500	WS 4 June
					12 June
					7 July
					21 Aug.
AF#150	11	1972	Whale Skate	A1094	TE 16 Mar
					17 Mar
					24 Mar
					25 Apr
					27 Apr
					16 June
					WS 18 Jul

Table 13 con't.

Sex & I.D.#	Age	Year Tagged	Island Tagged	Tag No.	Island-Resighting	
AF#159	16	1967	Trig	A8	TE	31 Jan
					WS	19 Jun
					TE	22 Aug
AF#171	14	1969	Whale Skate	A796	WS	6 Jun
AF#173	13	1970	Round	A763	EA	18 May
						12 Jun
						16 Jul
AF#206	13	1970	Round	A757	WS	15 May
						17 Jun
					EA	10 Jul
AF#218	12	1971	East	A954	WS	22 Jul
					EA	8 Jun
AM#108	14	1969	East	A786	TE	20 Jan
						21 Jan
						21 Feb
						24 Feb
					EA	9 Apr
					TE	1 May
AM#129	13	1970	Round	A760	EA	9 May
					TE	20 May
						29 May
						31 May
AM#165	13	1970	Round	A768	TE	8 Feb
AM#184	13	1970	Whale Skate	A923	WS	6 Jul
AM#183	13	1970	Whale Skate	A912	WS	8 Jun
						15 Jun
AM#249	12	1971	Shark	A986		6 Jul
					TE	27 Jan
						16 Feb
						16 Mar

The highest number of resightings were on Tern Island with AF I.D.# 150 and AM I.D.#108 comprising 58%. Tern was surveyed more frequently which probably explains the higher number of resightings. Tagged seals that were resighted from July 1979 through December 1981 were resighted during this study with the exception of AM I.D.#172, tag no. A788 and AF I.D.#182, tag no. A902. Tagged seals that were sighted in 1982 were re-

sighted during this study with the exception of AF I.D.#214, tag no. A-1043. AM I.D.#129, tag no. A760, was resighted for the first time since 23 July 1980 on Tern Island.

The loss of tags through natural circumstances, the difficulty of seeing the tags and the absence of major scars on tagged seals may help explain the low number of resightings. AF I.D.#'s 59, 171, 218 (who obtained her scar in June 1983) and AM I.D.#108 were the only tagged seals, sighted during this study, which had easily recognizable scars. AM I.D.#165 had no photographs to help in identification and the remaining seals, AF I.D.#'s 150, 159, 173, 206 and AM I.D.#'s 41, 129 and 183 had obscure scars that made identification and confirmation of resightings difficult.

Sector Preference of Known Seals on Tern

The sector preference of known seals which hauled out on Tern Island during this study is shown in Tables 14, 15 and 16.

Table 14. Sector Preference of Known Adult Males on Tern Island.

AM I.D.#	# of Sectors Used	# of Sightings	# of Sightings in Each Sector									
			1	2	3	4	5	6	7	8	9	10
2	4	9	2	1	*	2	4	*	*	*	*	*
6	4	8	*	3	*	1	3	1	*	*	*	*
20	5	7	1	1	*	4	1	*	*	*	*	*
23	3	5	*	*	3	1	*	1	*	*	*	*
28	5	14	1	1	1	*	*	*	*	5	6	*
31	5	10	1	3	1	2	2	*	*	*	*	*
32	3	7	*	*	3	2	2	*	*	*	*	*
36	2	3	*	2	*	1	*	*	*	*	*	*
37	3	3	*	1	1	1	*	*	*	*	*	*
38	4	23	5	14	1	3	*	*	*	*	*	*
40	4	4	*	1	1	1	*	1	*	*	*	*
42	3	14	*	3	1	7	1	2	*	*	*	*
44	2	16	*	*	5	11	*	*	*	*	*	*
50	2	4	*	*	1	*	*	4	*	*	*	*
52	4	5	*	1	1	*	1	2	*	*	*	*

Table 14 con't.

AM I.D.#	# of Sectors Used	# Of Sightings	# of Sightings in Each Sector									
			1	2	3	4	5	6	7	8	9	10
58	4	9	1	*	3	3	*	1	*	*	*	*
71	1	2	*	*	*	*	2	*	*	*	*	*
74	1	1	*	*	*	*	*	*	*	1	*	*
77	6	12	1	4	1	4	1	1	*	*	*	*
82	4	7	*	4	1	1	1	*	*	*	*	*
88	5	10	*	1	1	5	2	1	*	*	*	*
89	3	9	1	6	2	*	*	*	*	*	*	*
96	5	9	*	2	*	1	2	1	*	*	*	*
99	3	5	*	1	3	1	*	*	*	*	*	*
102	3	7	*	1	2	4	*	*	*	*	*	*
106	3	11	*	*	3	6	2	*	*	*	*	*
108	2	5	*	4	*	1	*	*	*	1	*	*
111	2	11	2	8	*	*	*	*	*	*	*	*
114	3	4	1	*	2	1	*	*	*	*	*	*
116	1	1	*	1	*	*	*	*	*	*	*	*
121	2	3	*	2	*	*	1	*	*	*	*	*
129	1	3	*	3	*	*	*	*	*	*	*	*
130	2	4	*	2	*	*	2	*	*	*	*	*
131	3	17	*	13	3	*	1	*	*	*	*	*
134	3	5	*	*	2	2	*	2	*	*	*	*
136	2	4	*	*	*	*	1	3	*	*	*	*
142	2	3	*	*	2	1	*	*	*	*	*	*
143	4	8	1	*	4	2	*	1	*	*	*	*
153	6	7	1	1	1	2	1	1	*	*	*	*
161	3	10	*	5	3	*	*	1	*	*	*	*
165	1	1	*	1	*	*	*	*	*	*	*	*
168	4	13	6	3	2	1	*	*	*	*	*	*
188	1	1	*	*	1	*	*	*	*	*	*	*
191	4	6	*	1	1	1	1	2	*	*	*	*
215	3	8	*	5	2	*	*	1	*	*	*	*
219	2	2	*	1	*	1	*	*	*	*	*	*
242	1	2	*	*	*	*	1	*	*	*	*	*
249	1	3	*	*	3	*	*	*	*	*	*	*
250	3	9	*	6	*	1	1	*	*	*	*	*
254	2	5	*	4	*	*	*	1	*	*	*	*
259	1	4	*	4	*	*	*	*	*	*	*	*
270	1	1	*	*	*	1	*	*	*	*	*	*
Totals:			23	114	61	76	32	27	0	7	6	0

Table 15. Sector Preference of Known Adult Females on Tern Island.

AF I.D.#	# of Sectors Used	# of Sightings	# of Sightings in Each Sector									
			1	2	3	4	5	6	7	8	9	10
4	2	3	*	*	*	1	*	2	*	*	*	*
9	3	10	3	6	*	*	1	*	*	*	*	*
10	3	5	1	4	*	*	*	1	*	*	*	*
14	4	13	*	6	4	1	2	*	*	*	*	*
26	5	13	9	*	1	1	1	1	*	*	*	*
27	2	21	13	8	*	*	*	*	*	*	*	*
29	2	4	*	*	3	1	*	*	*	*	*	*
33	4	12	4	3	*	*	4	*	*	*	*	*
56	4	8	3	*	1	*	1	3	*	*	*	*
63	5	20	*	13	3	3	1	*	1	*	*	*
69	1	3	*	*	*	*	*	3	*	*	*	*
70	1	1	*	1	*	*	*	*	*	*	*	*
72	4	25	*	*	9	9	2	5	*	*	*	*
78	2	3	*	*	2	1	*	*	*	*	*	*
94	4	10	3	*	*	4	1	*	*	*	2	*
103	3	4	*	1	2	1	*	*	*	*	*	*
107	4	13	*	1	10	*	1	1	*	*	*	*
110	2	13	6	7	*	*	*	*	*	*	*	*
128	3	6	*	2	*	*	2	1	*	*	*	*
144	2	7	*	*	1	6	*	*	*	*	*	*
145	2	12	*	*	2	8	2	*	*	*	*	*
150	1	6	*	*	*	*	6	*	*	*	*	*
159	2	2	*	*	*	1	1	*	*	*	*	*
178	3	10	*	*	*	4	2	4	*	*	*	*
180	3	7	*	*	3	2	2	*	*	*	*	*
201	1	1?	*	*	*	1	*	*	*	*	*	*
223	1	2	*	*	*	*	*	2	*	*	*	*
227	2	3	*	*	*	*	1	2	*	*	*	*
234	1	1	*	*	*	1	*	*	*	*	*	*
253	2	6	*	4	*	2	*	*	*	*	*	*
257	2	1	*	*	*	*	*	2	*	*	*	*
269	1	1	*	*	*	*	*	1	*	*	*	*
272	1	4	*	*	*	*	*	4	*	*	*	*
Totals:			41	56	36	47	28	32	1	0	2	0

?=unconfirmed sighting

Table 16. Sector Preference of Known SM's, SF's, JM's JF's on Tern.

SM I.D.#												
47	4	8	*	3	2	2	1	*	*	*	*	*
48	3	11	*	3	6	2	*	*	*	*	*	*
76	2	3	*	1	2	*	*	*	*	*	*	*

Table 16 con't.

SM I.D.#	# of Sectors Used	# of Sightings	# of Sightings in Each Sector									
			1	2	3	4	5	6	7	8	9	10
133	2	3	*	*	1	2	*	*	*	*	*	*
141	4	16	13	1	1	*	*	1	*	*	*	*
158	3	5	2	*	*	*	*	1	2	*	*	*
170	4	7	2	1	2	1	*	1	*	*	*	*
238	3	9	*	*	1	5	2	*	*	*	*	*
Totals			17	9	15	12	3	3	2	0	0	0

SF I.D.#												
30	3	9	2	6	*	1	*	*	*	*	*	*
55	4	16	1	10	*	*	1	4	*	*	*	*
61	2	7	*	2	5	*	*	*	*	*	*	*
132	1	3	*	3	*	*	*	*	*	*	*	*
147	4	11	*	2	7	2	*	1	*	*	*	*
162	4	9	2	3	1	1	2	*	*	*	*	*
268	1	4	4	*	*	*	*	*	*	*	*	*
Totals:			9	26	13	4	3	5	0	0	0	0

JM I.D.#												
18	2	3	2	1	*	*	*	*	*	*	*	*
45	1	6	6	*	*	*	*	*	*	*	*	*
62	5	7	1	2	1	2	*	*	1	*	*	*
76	2	3	1	2	*	*	*	*	*	*	*	*
112	2	2	*	*	1	*	1	*	*	*	*	*
Totals:			10	5	2	2	1	0	1	0	0	0

JF I.D.#												
101	5	6	1	1	2	1	1	*	*	*	*	*
181	1	1	*	1	*	*	*	*	*	*	*	*
211	2	3	*	2	*	*	*	1	*	*	*	*
252	3	4	1	2	*	*	1	*	*	*	*	*
Totals:			2	6	2	1	2	1	0	0	0	0

Known AM's were resighted in all of the sectors except for 7 and 10. The highest number of resightings for hauled out known AM's was in sector 2, followed by sectors 4, 3, 5, 6, 1, 8 and 9. Known AF's were resighted in all of the sectors except 8 and 10 with the highest number of resightings in sector 2, followed by 4, 1, 3, 6, 5, 9 and 7. Known AM's and AF's both preferred to haul out in sectors 2 and 4.

The Tern Island photo files contain a small sample, 24, of subadults

and juveniles. These immatures preferred to haul out on the south side of Tern, in sectors 1-6. There were no sightings of known immature seals, excluding weaners, in sectors 8, 9 and 10.

Sector utilization by known AM's and AF's is summarized in Table 17. Data showed that 32% of the AM's utilized at least 3 sectors and 31% of the AF's utilized at least 2 sectors. Sector utilization for known immature seals was not computed because of the small sample size.

Table 17. Summary of Sector Use by Known AM's and AF's.

# Known AM's	# of Sectors Utilized	% of Utilization
9	1	17
11	2	21
17	3	32
9	4	17
4	5	7
2	6	3
0	7-10	0

# Known AF's	# of Sectors Utilized	% of Utilization
9	1	28
10	2	31
6	3	18
5	4	15
2	5	6
0	6-10	0

Sightings of Bleach Marked Weaners on Tern Island

The first artificially bleach marked weaner, this year's weaned pup, was sighted in sector 8 on 30 May 1983. There were 25 resightings of weaners since that date during the 4 day surveys; 18 were resighted in sectors 7, 8, 9, and 10; 4 in sector 1; 2 in sector 6; and 1 in sector 2. Though this was a small sample size it does appear that the weaners hauled out on either the north side or extreme west ends of Tern Island.

This trend needs to be looked at more carefully. Sectors 7, 8, 9, and 10 were seldom used by any other age group (Table 18).

Table 18. Resightings of Bleach Marked Weaners on Tern Island.

Bleach Mark	Sex	Resight Date	Sector
BA	M	30 May	8
BA	M	8 June	10
BA	M	12 June	10
BA	M	24 June	8
BA	M	2 July	10
BE	F	6 July	8
BF	F	10 July	9
BF	F	14 July	6
BM	F	14 July	8
BW	M	18 July	9
BP	M	18 July	9
GH	F	18 July	2
BW	M	22 July	10
BW	M	26 July	1
EK	F	26 July	1
BW	M	3 August	1
RG	F	3 August	6
EN	M	7 August	10
EG	M	15 August	8
BX	M	15 August	8
BV	F	15 August	9
EJ	F	23 August	7
BA	M	27 August	1
EE	M	27 August	8
GS	M	31 August	9

Known Molting Seals on Tern

There were 9 known seals who either partially or completely molted on Tern Island during this study period. The molt intervals in Table 19 are misleading as the % molt was recorded only every 4th day. The first known seal to completely molt was AF I.D.#145. AF I.D.#14 molted on Tern for the 4th consecutive year and AF I.D.#144 molted on Tern for the 3rd consecutive year in sector 4. AF I.D.#33 molted on Tern for the 2nd consecutive year (Table 19).

Table 19. Known Seals Which Molted On Tern From 1 January 1983-31 August 1983.

	1980	1981	1982	1983
AF#14	Molt Date 19-29 June Island Tern Sector(s) 3	29 May-? Tern 2 and 5	8-19 July Tern 3 and 4	26 July-12 Aug Tern 3, 4, and 5
AF#33	Molt Date Island Sector(s)		25Aug-8Sept Tern 1 and 2	20June-5 Jul Tern 5
SF#61	Molt Date Island Sector(s)			10-22 July Tern 3 and 4
AF#144	Molt Date Island Sector(s)	May Tern 4	21May-5Jun Tern 4	1-20 Jun Tern 4
AF#145	Molt Date Island Sector(s)		17May-8Jun Tern 6	19May-8Jun Tern 4

Sightings of monk seals on Tern Island were rare prior to 1979. Tern apparently became an attractive molting island to several known AF's after that date. The examples cited suggest that these known AF's have established a preferred island to molt on and in the case of AF I.D.#144, a sector preference.

One known AF, 2 known SF's, and 1 known SM partially molted on Tern during this study (Table 20).

Table 20. Molt Intervals of Known Seals Who Partially Molted on Tern.

	MAY	JUNE	JULY	AUGUST
Pre-molt	*	*	*	*
SM I.D.# Molt Interval	*	*	6-10	*
48 % Molt During Interval	*	*	40-100	*
Sector	*	*	3	*

Table 20 con't.

		MAY	JUNE	JULY	AUGUST
	Pre-molt	*	28-30	1-?	*
SF I.D.#	Molt Interval	*	*	?-18	*
55	% Molt During Interval	*	*	40	*
	Sector	*	*	6	*
	Pre-molt	*	*	25-31	1
AF I.D.#	Molt Interval	*	*	*	2-3
72	% Molt During Interval	*	*	*	1
	Sector	*	*	*	6
	Pre-molt	*	*	*	*
SF I.D.#	Molt Interval	11-19	*	*	*
147	% Molt During Interval	1-75	*	*	*
	Sector	3	*	*	*

Only SF I.D.#147 had a molting history on Tern. AF I.D.#72 was 1% molted on Tern on 2 August 1983 but was not resighted on Tern until 23 August 1983 when she was 100% molted. This data suggests that there may be some intraatoll movement during molt. No known AM's molted during this study.

This information is only preliminary as the molting season is not completed.

Intraatoll Movements of Known Adult Females Prior to Popping

There are 108 known adult females in the active files at FFS. During this study period 40 of these known AF's pupped (Table 21).

Table 21. Pupping History and Island Fidelity of Known Adult Females.

AF#	PUPPING DATE ISLAND	1980	1981	1982	1983
		1		July/ August ² East	Mid-July ³ East
AF#4	PUPPING DATE ISLAND				
AF#8	PUPPING DATE ISLAND				10 May ⁴ East
AF#9 ⁵	PUPPING DATE ISLAND	May East	May-June East	June East	31 May East
AF#10	PUPPING DATE ISLAND	Aug East			
AF#11	PUPPING DATE ISLAND				May W.S.
AF#14	PUPPING DATE ISLAND			April East	Mid-April East
AF#19	PUPPING DATE ISLAND			Jun/July East	
AF#29	PUPPING DATE ISLAND				26 May East
AF#33	PUPPING DATE ISLAND		May East	June East	
AF#46	PUPPING DATE ISLAND		June East		April East
AF#56	PUPPING DATE ISLAND			June East	4 June* East
AF#59	PUPPING DATE ISLAND			July W.S.	7 July W.S.
AF#60	PUPPING DATE ISLAND			April/May East	
AF#67	PUPPING DATE ISLAND			June W.S.	June W.S.
AF#70	PUPPING DATE ISLAND		July L. Gin	May W.S.	
AF#72	PUPPING DATE ISLAND		June W.S.	July W.S.	
AF#78	PUPPING DATE ISLAND				June Mullet
AF#83	PUPPING DATE ISLAND	Oct/Nov East	Nov East		

		1980	1981	1982	1983
AF#84	PUPPING DATE ISLAND				April Triglet
AF#87	PUPPING DATE ISLAND			May East	
AF#94	PUPPING DATE ISLAND		June W.S.		
AF#103	PUPPING DATE ISLAND				April* W.S.
AF#107	PUPPING DATE ISLAND			June Round	
AF#113	PUPPING DATE ISLAND		June(?) East		
AF#135	PUPPING DATE ISLAND			June W.S.	28 July-1 Aug. W.S.
AF#138	PUPPING DATE ISLAND			July East	
AF#149	PUPPING DATE ISLAND		May/June East	May/June East	2-8 July East
AF#150	PUPPING DATE ISLAND			June/July W.S.	9-17 July W.S.
AF#152	PUPPING DATE ISLAND			June/July W.S.	12 June East
AF#154	PUPPING DATE ISLAND		June East	June East	
AF#156	PUPPING DATE ISLAND			May East	
AF#169	PUPPING DATE ISLAND		June East	July East	
AF#171	PUPPING DATE ISLAND				6 June W.S.
AF#173	PUPPING DATE ISLAND		May East	May/June East	
AF#180	PUPPING DATE ISLAND				Early May East
AF#185	PUPPING DATE ISLAND			June/July East	16 Apr-26Apr. East
AF#190	PUPPING DATE ISLAND				May W.S.
AF#199	PUPPING DATE ISLAND			June/July W.S.	Late July W.S.

Table 21 cont.

	1980	1981	1982	1983
AF#202 PUPPING DATE ISLAND		June W.S.		
AF#203 PUPPING DATE ISLAND			June East	June East
AF#209 PUPPING DATE ISLAND		May East	May/June East	Mid-May East
AF#212 PUPPING DATE ISLAND	Apr/May East		May/June East	June East
AF#213 PUPPING DATE ISLAND			Aug. W.S.	Early Aug. W.S.
AF#216 PUPPING DATE ISLAND			July/Aug. East	
AF#218 PUPPING DATE ISLAND				June East
AF#220 PUPPING DATE ISLAND			May East	Late Apr. East
AF#221 PUPPING DATE ISLAND			May East	
AF#222 PUPPING DATE ISLAND			May/June East	
AF#223 PUPPING DATE ISLAND			Apr. East	4-10 May East
AF#224 PUPPING DATE ISLAND			May East	
AF#226 PUPPING DATE ISLAND			Sept. W.S.	
AF#227 PUPPING DATE ISLAND				31 May W.S.
AF#228 PUPPING DATE ISLAND				Mid-April Round
AF#229 PUPPING DATE ISLAND			May W.S.	
AF#231 PUPPING DATE ISLAND			Aug. East	
AF#232 PUPPING DATE ISLAND			May/June W.S.	June ⁶ W.S.
AF#233 PUPPING DATE ISLAND		May East	May/June East	
AF#234 PUPPING DATE ISLAND	Apr/May East	May East		

	1980	1981	1982	1983
AF#240 PUPPING DATE ISLAND			July East	
AF#243 PUPPING DATE ISLAND				May ⁷ Round
AF#255 PUPPING DATE ISLAND				April East
AF#257 PUPPING DATE ISLAND				April/May W.S.
AF#262 PUPPING DATE ISLAND				Early June East
AF#264 PUPPING DATE ISLAND				March East
AF#266 PUPPING DATE ISLAND				May East
AF#271 PUPPING DATE ISLAND				July East
AF#273 PUPPING DATE ISLAND			July W.S.	July W.S.

¹blank space =no sightings only

²approximate pupping months

³month known but not exact pupping date

⁴Exact pupping date known

⁵pupped in 1976 on East

⁶not a confirmed sighting

⁷not a confirmed sighting

*stillborn

Twenty seven AF's were not sighted prior to pupping (Table 22).

Table 22. Adult Females Not Sighted Prior to Pupping.

I.D.#	Pupping Date	Island
8	10 May	East
11	May	WS
46	April	East
67	June	WS
78	June	MU
84	April	Triglet*
103	April	WS
171	6 June	WS
180	Early May	East
185	Mid-April	East

Table 22 con't.

I.D.#	Pupping Date	Island
190	May	WS
199	Late July	WS
203	June	East
209	Mid-May	East
212	June	East
218	June	East
220	Late-April	East
223	May	East
232	June	WS ¹
243	May	Round ²
255	April	East
257	April-May	WS
262	Early June	East
264	March	East
266	May	East
271	July	East
273	July	East

* Trig is presently two islands

¹ not a confirmed sighting

² not a confirmed sighting

Eight AF's were sighted, on islets other than their pupping islets, from 6 weeks to two days prior to pupping (Table 23).

Table 23. Intraatoll Movements of Known AF's, 6 wks-2 days Prior to Pupping.

I.D.#	Sighting Date	Island	Pupping Date	Island
9	29 May	Tern	31 May	East
14	23 March	Tern	Late-April	East
29	1 May	Tern	26 May	East
56	28 May	WS	4 June	East
150	16 June	Tern	9-17 July	WS
152	9 June	WS	12 June	East
228	9 April	WS	Mid-April	Round
262	23 April	Dis.	Early June	East

Six AF's were sighted, on their pupping islets, 3 to 8 days prior pupping, but it is not known whether they remained on these islets for the entire interim until pupping (Table 24).

Table 24. Known AF's Sighted on Their Pupping Islet 3-8 Days Prior to Pupping.

I.D.#	Sighting Date	Islet	Pupping Date	Islet
4	17 July	East	17-25 July	East
59	4 June	WS	7 July	WS
135	28 July	WS	28 July-1 Aug.	WS
149	30 June	East	2-8 July	East
213	4 Aug.	WS	Early Aug.	WS

AF I.D.#9 was sighted on 29 May on Tern and pupped on 31 May 1983 on East, a distance of 6.5 miles. AF I.D.#9 pupped on East in 1976, 1980, 1981, 1982, and 1983. There is no data for the intervening years. This example suggests that she exhibited a traditional pupping ground fidelity and was not likely to pup on Tern. Except for AF's I.D.#'s 152 and 70, known AF's who have pupped appear to be very islet specific.

AF I.D.#152 was sighted on 9 June 1983 on Whale-Skate and pupped on 12 June 1983 on East, a distance of 3 miles. In 1982, she pupped on Whale-Skate. AF I.D.#70 is the only other known seal, with a pupping history, who pupped in two consecutive years on different islets. In 1982, she pupped on Little Gin which does not appear to be a popular pupping islet but in 1983 she pupped on Whale-Skate, a popular pupping islet.

The intraatoll movement of AF's I.D.#9 and 152 indicated that pregnant AF's are capable of traveling some distance prior to pupping.

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A DESCRIPTION AND ECONOMIC APPRAISAL OF CHARTER BOAT FISHING IN HAWAII

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Table 4.6 Frequency of Charter Fishing Trips Taken by Owner-Operators and Absentee Owners

Number of Trips Taken in 1982	Owner-Operators		Absentee Owners	
	Number	Percent	Number	Percent
1- 40	0	0%	3	10%
41- 80	6	46	4	14
81-120	3	23	5	17
121-160	0	0	7	24
161-200	0	0	1	3
201-240	1	8	4	14
240+	3	23	5	17
TOTAL	13	100%	29	99%(a)

(a) Deviation from 100% due to rounding error.

A DESCRIPTION AND ECONOMIC APPRAISAL
OF CHARTER BOAT FISHING IN HAWAII

FINAL REPORT

by

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April, 1984

PREFACE

This report was prepared under contract (82-ABC-00216) by Dr. Karl Samples of the University of Hawaii, College of Tropical Agriculture. The study was a joint undertaking of the Hawaii Institute of Tropical Agriculture and Human Resources (University of Hawaii) and the Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA. The objectives of the contract was to present the results and analyze a survey of charter boat operators in the State of Hawaii. The survey was designed to describe the charter boat fishery, identify factors important to its success, and provide information to estimate the impact of the industry on Hawaii's economy. The survey took place in 1983 and reports charter boat characteristics for the previous year.

Since this report was prepared under contract, its statements, findings, conclusions, and recommendations are those of Dr. Samples and his associates, and do not necessarily reflect the views of the National Marine Fisheries Service.

Samuel G. Pooley
Industry Economist

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This research was supported by the Hawaii Institute of Tropical Agriculture and Human Resources, University of Hawaii; and by the National Marine Fisheries Service, Southwest Fisheries Center, Honolulu Laboratory through NOAA Contract #82-ABC-00216, U.S. Department of Commerce. The authors wish to express their sincere appreciation to those charter boat owners who took time to answer our many questions about the operating characteristics of their business. Without this information, our study would have been impossible to complete. Hopefully, the information we have assembled in this report will assist charter fishing boat owners, individually and collectively, to more readily achieve their business objectives. A special note of thanks is extended to Mr. Samuel G. Pooley, Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, for his constant input of novel ideas and his overall support for this research endeavor. Research assistance by Mr. Donald Schug was also valuable in completing the study. The excellent secretarial services provided by the Department of Agricultural and Resource Economics staff is also hereby acknowledged. Of course, responsibility for all errors and omissions remains our own.

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EXECUTIVE SUMMARY

The purpose of this study is to describe Hawaii's charter boat fishing fleet in terms of its composition, and its biological and economic impacts. A mail questionnaire survey of charter boat owners was conducted in 1983, to collect data on 1982 operating characteristics of their vessels. The survey yielded 73 usable returns. A follow-up telephone survey of non-respondents confirmed that mail survey respondents were representative of the entire population.

Using results of mail and telephone surveys, the size of the charter fleet operating in 1982 was estimated to be 119 boats. The fleet operated out of ports located on all of the populated Hawaiian Islands (except Lanai and Nihoa), with a majority based on the islands of Oahu and Hawaii. The most prominent charter fishing home ports were determined to be Kewalo Basin (Oahu) and Honokohau (Hawaii).

During 1982, the fleet produced an estimated 73,780 passenger trips. The majority of trips were full-day private charters priced at \$355 on average. Hawaii nonresidents were responsible for the bulk of charters.

The fleet generated an estimated \$8.1 million in total revenue in 1982, mainly from sales of charter fishing trips and fish caught while charter fishing. Indirect and induced sales amounted to an additional \$8 million. Estimated charter fishing direct sales compare closely with sales volumes estimated for the Hawaii surfshop industry of \$9.1 million, and are about 20% higher than the \$6.7 million in retail sales generated by Hawaii's diving industry. Compared to total 1982 sales made in the State of Hawaii (\$20,722 million), direct charter sales represent about .03%.

The industry directly employed 203 people (full-time equivalent basis) in 1982, and indirectly created an additional 269 full-time positions as a result of purchases from other economic sectors. In terms of direct employment, charter fishing activities in the State created 240% more positions than the scuba industry that employed 84 people on a full-time basis. Out of a total 1982 statewide employment level of 442,350, the charter fishing industry was directly responsible for about .04%.

Total fish catch in 1982 by the charter fishing fleet, exclusive of fish landed while commercial fishing, was estimated to be about 2.2 million pounds. This quantity represents 15% of the total reported commercial fish landings for Hawaii in 1982. The importance of charter catches for certain specific fish species was more pronounced. For example, the estimated blue marlin catch by the fleet (803,250 lbs) was 180% higher than the total commercial blue marlin catch reported in 1981.

Taken together, these findings suggest that charter fishing is an economically and biologically significant commercial marine activity. Compared to total economic activity occurring in the State of Hawaii, however, the charter fishing industry is somewhat insignificant.

Individual vessels comprising the fleet appear to be heterogeneous in terms of vessel activity levels, construction characteristics and owner demographic characteristics. Both full-time and part-time operations were observed, of which about a half were owner-operator. Significant under-utilization of capacity was seen to exist, with many vessels operating less frequently than necessary to breakeven financially. As a result, the fleet, on average, realized a before-tax loss in 1982. However, it was also observed that low profitability is characteristic of charter fishing fleets operating in other areas of the United States.

1.0

INTRODUCTION

Although charter sport fishing is a prominent commercial marine activity in Hawaii, little attention has heretofore been devoted to examining the industry in detail. Only one earlier study, conducted for National Marine Fisheries Service, attempted to identify the characteristics of Hawaii's charter fleet and its economic and biological impacts (National Marine Fisheries Service, 1983). This 1976 study was limited in scope to examining charter boat operations in the Kailua-Kona area on the island of Hawaii, and no attempt was made to expand the results to a statewide basis. The goal of this particular research endeavor was to fill an informational void by illuminating the operating characteristics, social and biological impacts, and activities of the entire charter boat fleet operating in Hawaii. Specifically, the objectives of the study were:

- 1) To develop socioeconomic profiles of charter boat operators;
- 2) To estimate the expected costs and returns associated with charter fishing operations in Hawaii;
- 3) To measure the statewide economic and employment impacts of charter vessel operations.

This report of research findings is organized in the following manner. Data acquisition procedures are described in the next section with emphasis on sample design and survey procedures. In the third section, a statistical profile of Hawaii's charter fleet is presented. Readers will find this section to contain detailed descriptive information about the fishing boats, vessel owners and catch characteristics, as well as information on fishing activity levels. Costs and returns associated with charter fishing in Hawaii are addressed in the fourth section, and factors influencing vessel profitability are analyzed. For purposes of comparison with other charter fleets in the United States, the fifth section contains a discussion of vessel owner characteristics, charter fishing activity levels, fare structures and operating cost/returns for nine different areas in the United States, including Hawaii. A discussion of the direct and indirect employment, sales, and income impacts associated with Hawaii charter fishing in 1982 is presented in the sixth section. This section provides a perspective on the overall contribution which the charter fishing industry makes to the State's economy. Attitudes of charter boat owners about State management of their industry are described in the seventh section. Finally, the report concludes with remarks about the future prospects for charter boat fishing in Hawaii.

2.0

METHODS

2.1 Identification of Charter Boat Population

It is not a simple matter to distinguish the population of bona-fide charter boats from the remainder of approximately 14,500 boats registered in Hawaii. A preliminary list of names and addresses of charter fishing vessel owners was obtained from the "Hawaii Fishing Vessel Inventory," maintained by the National Marine Fisheries Service (NMFS), Southwest Fisheries Center Honolulu Laboratory, Honolulu, Hawaii. The "Hawaii Fishing Vessel Inventory" is the result of the efforts by NMFS, the State, and the Western Pacific Fishery Management Council to assemble registration information from the Hawaii Department of Transportation (Harbors Division) and the U.S. Coast Guard relating to all types of fishing vessels operating in Hawaii. Commercial vessels (fishing and non-fishing) under 5 tons displacement are registered with the Hawaii Harbors Division as "Registered Undocumented" (referred to hereafter simply as registered vessels). Commercial vessels greater than 5 tons displacement are licensed with the Coast Guard as "Documented" and will be referred to as such in this report. Two vessel sub-classifications: "charter-fishing" and "passenger-fishing," are used by the State of Hawaii Harbors Division and U.S. Coast Guard, respectively. It is the combination of these two sub-classifications which constitutes the NMFS vessel inventory of charter fishing vessels. From this inventory of 214 documented and registered "charter fishing" boats, information was obtained about the owner's name, address, boat description and vessel identification number.

Dependence on the NMFS vessel inventory as a preliminary means of identifying charter vessels operating in Hawaii was based on the apparent inclusiveness of the inventory listing. Owners of registered and documented vessels are required by the Harbors Division and Coast Guard to annually license their vessels according to principal boat use or service. While it cannot be assured that all boats which are even remotely involved in commercial charter fishing are categorized as such, incentives to be classified as a charter fishing vessel are quite high. Bona-fide charter fishermen, for example, enjoy a tax advantage of being able to deduct costs of fishing. This of course is also true for vessels that are used for commercial fishing purposes. However, there is a difference in the fact that vessels which are categorized as "commercial fishing" cannot legally be used for any other marine commercial service. Furthermore, documented vessels listed under any category other than "passenger fishing" cannot legally engage in charter fishing. In contrast, a "passenger fishing" categorization affords a vessel owner the option to engage in commercial fishing, charter fishing, charter

tours, or simply pleasure boating. Thus the incentive for charter fishermen to identify their boats as passenger-fishing for registration purposes is great because this listing offers the greatest degree of flexibility in commercial vessel uses.

The disincentives in licensing a vessel as commercial-fishing or charter fishing are about equal. A tax is imposed by the Hawaii State Harbors Division on all boats holding a commercial permit (including charter fishing vessels). All such vessels are required, on a monthly basis, to pay the State a user fee equal to either twice the monthly slippage fee, or 2% (1.5% in 1982) of their gross monthly income, whichever is greater.

A physical search through vessel documentation records revealed six additional boats not included in the NMFS inventory due to their recent transfer of ownership. Using a combined list of boats, it was determined that there were nine owners with two boats listed under their names and one owner with three boats. One of the boats on the combined list had been repossessed by a finance company, thus bringing the maximum potential size of charter fishing boat owners in Hawaii to 208 (220-9-2-1). These 208 boat owners comprised the target population for a mail questionnaire survey.

2.2 Mail Questionnaire Development and Fielding

The principal source of data used in this study was charter fishing vessel owners' responses to a mail questionnaire survey. A questionnaire instrument was drafted, reviewed internally, and then circulated for comment to sixteen pre-selected reviewers representing the charter fish industry, government agencies, and other interested groups. The instrument was subsequently revised to accommodate reviewers' comments. The final version included six sections containing questions for boat owners about 1) their attitudes about public policy issues confronting the industry; 2) their 1982 fish catch and the perceived importance of catching certain fish to charter customers; 3) the costs and returns associated with their charter fishing operations in 1982; 4) types of fishing and other commercial boating activities engaged in during 1982; 5) fishing activity at fish aggregating devices, and 6) their socioeconomic background. A copy of the final questionnaire is reproduced in Appendix A. For aesthetic reasons, the questionnaire was printed on blue colored paper and assembled in a 5.5" x 8.5" booklet format.

The survey process began with an advance letter on January 13, 1983. The letter explained the goals of the study, informed respondents to expect the forthcoming questionnaire, and encouraged participation in the study. Owners of more than one boat received a similar letter with the added request that they aggregate the data on their boats and report the aggregate amount in their questionnaire booklets. Within a week after the advance

letter mailing, a packet containing the questionnaire, an accompanying letter, and a self-addressed stamped return envelope was sent to each of the 208 fishing vessel owners. Owners were promised that the information they supplied would be held in strict confidence and would be reported in aggregate form only. Boat owners were assigned an identification number and questionnaires were numbered to correspond with the owner's assigned number. Identification of questionnaires allowed the return response rate to be fully monitored and served to identify owners who were unresponsive.

After the first mailing, an updated version of the NMFS vessel inventory listing was obtained. The new list indicated that four boats on the original NMFS vessel inventory had been sold. Since two of the boats sold belonged to multiple owners, it increased the number of boat owners by two. Concurrently, a listing of charter boats became available from the Hawaii International Billfish Association (HIBA). Names of 15 owners not on the original NMFS inventory were found. Cross-referencing the HIBA and NMFS listings by vessel registration numbers disclosed that 2 of the 15 new names were associated with boats already on the NMFS inventory, but under different owners. A packet containing material identical to that which was mailed to the original 208 boat owners was mailed to 19 additional people. Although a total of 227 ($208+4+15$) people received the questionnaire, the maximum number of possible boat owners was only 223 ($208+2+13$). The difference stemmed from the fact that 4 of the boats included in the 227 are associated with 2 different owners and hence 4 owners had to be subtracted from the total to reflect 1 rather than 2 owners per boat.

Based on respondents' comments, returned questionnaires were classified as either charter fishing or non-charter fishing operations (i.e. sailboats, commercial fishing boats, pleasure boats, dive boats, etc.). Respondents who indicated they owned charter fishing boats but did not engage in charter fishing in 1982 were classified as non-charter for purposes of survey management. A number of questionnaires were returned either partially completed or blank and were not used for purposes of further study. Some owners removed the identification number from their questionnaire and were classified as unidentifiable. Several of the questionnaires also proved to be undeliverable by mail.

After one week, all boat owners were sent a postcard to remind them to return the questionnaires promptly. A second wave of questionnaire packets was put into the field eight weeks after the first. The second wave comprised 154 packets; with each packet containing the original questionnaire, a different accompanying letter, and a self-addressed stamped envelope.

The third and final wave of questionnaires was sent out by certified mail in order to convey the importance of the study to

those boat owners who had not yet returned their questionnaires. The third wave consisted of 132 certified mail packets; with each packet containing the questionnaire, a different accompanying letter, and a self-addressed stamped envelope. The third wave was put into the field five weeks after the second wave. In Figure 2.1, a cumulative frequency histogram of returned questionnaires (i.e., charter, non-charter, partials, and blanks) illustrates returns over an 18-week fielding period. In Table 2.1, the response for various questionnaire mailings is summarized, and Table 2.2 shows questionnaire response by island. The overall response to the three waves of questionnaires yielded: 72 confirmed charter boat owners, 44 non-charter owners, 6 partial or blank questionnaires, 25 undeliverable (due either to owners leaving the State or changes of addresses), and 77 non-responding boat owners. The overall response rate for the questionnaire was therefore 55% $[(72 + 44 + 6)/223]$.

2.3 Follow-up Telephone Survey

Given that a significant percentage of the survey population did not respond to repeated questionnaire mailings, a method was sought to determine: 1) the actual proportion of non-respondents who were bona-fide charter fishing boat owners, and 2) whether or not the data collected by the mail survey reflected a representative sample of the actual population of charter boat owners in the State.

A separate follow-up telephone survey was conducted involving a sample of those individuals who did not respond to the mail questionnaire survey. The number of questions asked in the telephone survey was reduced, but question overlap with mail survey was substantial. Statistical comparisons could therefore then be drawn between the responses observed for the two survey groups. Such a comparison would provide the necessary information to confirm or refute the hypothesis that mail respondents comprised a representative sample of Hawaii charter fishing boat owners. A copy of the telephone survey instrument is provided in Appendix B.

The phone survey procedure consisted of calling telephone numbers of a selected sample of individuals who did not respond to mail questionnaire survey. The sample was stratified according to island of the non-respondents' residences (see Table 2.3). The survey was conducted over the time period between May 18 to May 26, 1983. A total of 26 boat owners were contacted. This represents approximately 12% of the original population (223) and 34% of all those individuals (from that same population) who did not respond to the mail survey.

The majority of boat owners reached by this survey required several calls before finally being contacted. This held especially true for those who were found to be charter boat

Figure 2.1 Cumulative Survey Response by Week

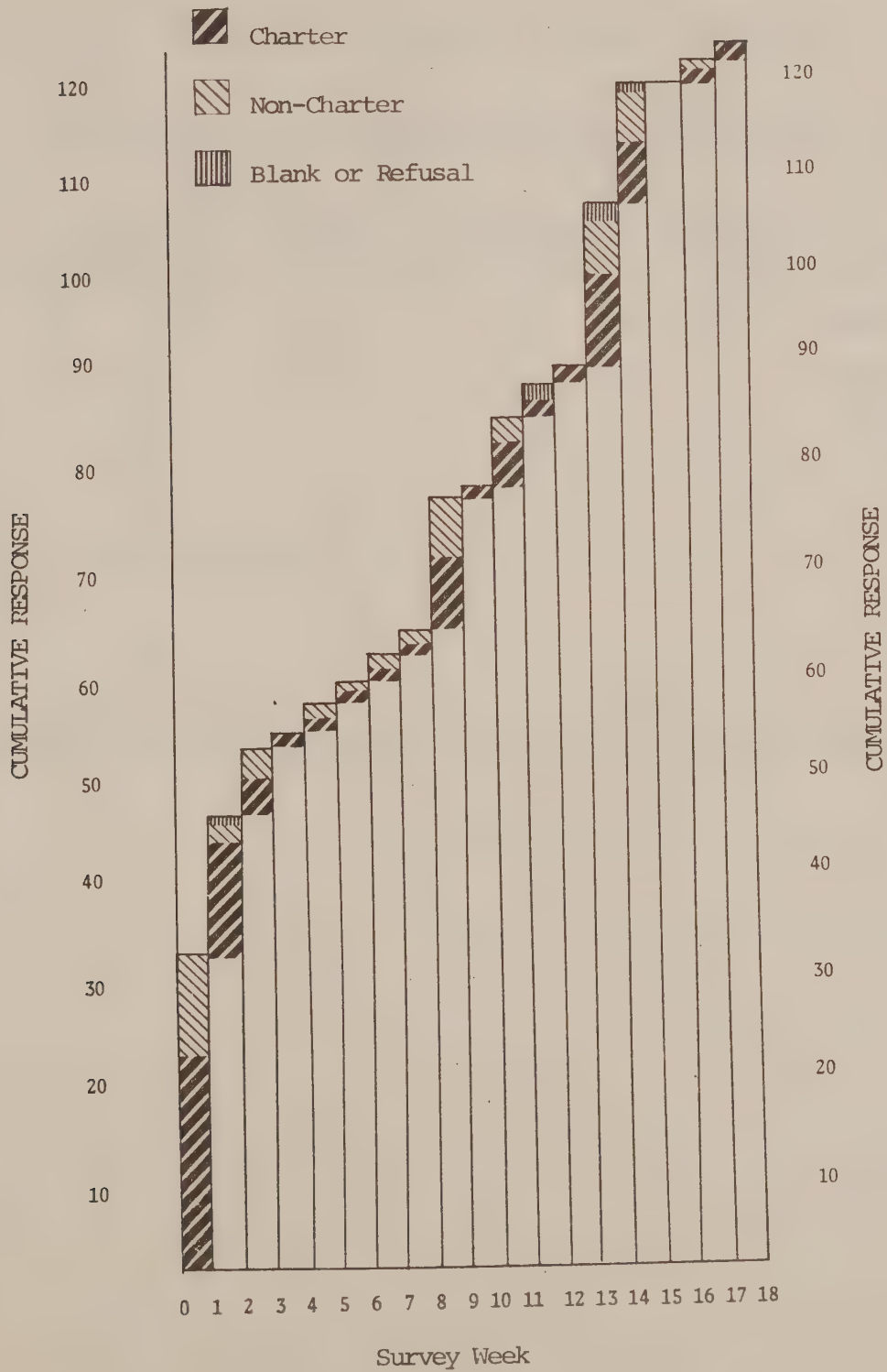


Table 2.1 Response of Survey Participants for Different Mailings

Mailing	Charter	Non-Charter	Blank	Undeliverable	Total
First Wave	40	23	1	12	76
Second Wave	14	9	2	0	25
Third Wave	18	12	3	13	46
TOTAL	72	44	6	25	147

Table 2.2 Response of Survey Participants: By Island of Owner's Residence

Island	Charter	Non-Charter	Blank	Undeliverable	Total
Oahu	24 (a)	21	3	6	54
Hawaii	30	15	1	10	56
Maui	12	7	1	5	25
Molokai	2	0	0	0	2
Kauai	3	0	0	2	5
Lanai	0	1	0	1	2
Mainland	0	0	0	1	1
Unidentified	1	0	1	0	2
TOTAL	72	44	6	25	147

(a) Includes one owner with two boats. Hence 25 boats were accounted for.

Table 2.3 Geographic Distribution of Survey Participants: By Island of Owner's Residence

Island	Mail Survey Population		Mail Survey Non-Respondents		Telephone Survey Sample	
	Number	Percent	Number	Percent	Number	Percent
Oahu	89	40	36	46	12	46
Hawaii	86	39	30	38	9	35
Maui	35	16	10	13	4	15
Molokai	2	1	0	0	0	0
Kauai	8	4	3	4	1	4
Lanai	2	1	0	0	0	0
Mainland	1	(b)	0	0	0	0
TOTAL	223	101(a)	79(c)	101(a)	26	100

(a) Deviation from 100 due to rounding error.

(b) Less than 1%.

(c) Includes two respondents who could not be identified. Actual number of non-respondents is 77.

fishermen. If after repeated attempts, a boat owner could not be reached, the owner was dropped from the sample and replaced with another randomly selected individual. This sampling method may have tended to introduce a bias against contacting charter boat owners. There was no a priori reason to suspect, however, that non-charter boat owners were on average more susceptible to being intercepted by telephone compared to charter boat owners, especially when calls were placed throughout the day and evening hours.

As might be expected, a large percentage (69%) of those finally contacted by telephone were non-charter boat owners. This finding suggests that the majority of the population of charter boat owners did respond to the mail survey. The remaining 31% of the telephone survey sample consisted of charter boat owners (see Table 2.4).

Table 2.4 Charter/Non-Charter Composition of Survey Respondents

	Mail Survey		Telephone Survey	
	Number	Percent	Number	Percent
Charter	72	62	8	31
Non-Charter	44	38	18	69
TOTAL	116 (a)	100	26	100

(a) Includes only those respondents who were positively identified as charter or non-charter.

3.0

STATISTICAL PROFILE OF CHARTER FISHING BOAT INDUSTRY

Results of the mail and telephone surveys were used to develop a statistical profile of Hawaii's charter fishing industry as it existed in 1982. First, an estimate of the number of vessels comprising the fleet was obtained as follows. First, a count was made of the number of boats owned by individuals responding to the mail survey. Two respondents owned two boats in 1982, so a total of 74 (72 + 2) charter fishing boats were initially accounted for. Close inspection and cross-referencing of partially completed and non-deliverable questionnaires revealed an additional 21 boats which operated in 1982. As a final measure, the proportion of charter boat owners identified in the telephone survey (31%) was used as a multiplicative factor for the group of non-responding boat owners in the mail survey (N = 77) to arrive at an estimated 24 additional bona-fide charter boat owners. Since it was already known from vessel records that all non-respondents owned only a single boat (whether charter or not), this added 24 boats to the total for an estimated fleet size of 119 (74 + 21 + 24). Of this total, detailed information was collected on 73 (61%) separate charter fishing vessels through the mail questionnaire survey.

The survey generated responses by charter boat owners residing on the islands of Hawaii, Oahu, Maui, Molokai and Kauai. Response from Molokai and Kauai was low, amounting to only five returned surveys altogether. Due to the need to preserve the confidentiality of responses supplied by these five boat owners, data for Kauai and Molokai are not reported below on an individual island basis. These data are, however, reflected in statewide figures.

3.1 Vessel Characteristics

3.1.1 Location and Ports Used

The geographic distribution of ports used by the 73 vessels for which data were obtained is depicted in Figure 3.1. The island of Hawaii appears to be the most popular island to base a charter fishing operation. Just under half (48%) of the survey group indicated that the ports of Honokohau, Kailua-Kona or Kawaihae, all located on the island of Hawaii, were home ports for the charter vessels they owned.

Oahu was indicated to be the next most popular island to base a charter fishing business. Overall, the island of Oahu was chosen by 27% of the survey respondents as the island on which their home port was located. For the island of Oahu, Kewalo Basin, located in Honolulu, was used most often as a base port

Figure 3.1 Number of Charter Boat Owners Reporting Various Ports as Bases of Operation: By Island



(18% of the time).

The islands of Maui and Kauai were found to be the third and fourth most commonly chosen islands as bases for a charter fishing business in Hawaii. Maui and Kauai were chosen by 17% and 8% of the survey respondents, respectively, as the island on which their base port was located. The most popular ports for Maui were Lahaina and Maalaea Harbor which were used by 10% and 6% of respondents, respectively. In Kauai, Nawiliwili and Port Allen harbors which were used as home ports for 4% and 3% of the total survey group, respectively. Finally, the island of Molokai served as a base of operation for two charter boat owners. No respondents indicated that the island of Lanai was a base port location.

3.1.2 Vessel Size, Age and Propulsion

The length of vessels comprising Hawaii's charter fleet in 1982 ranged from 20 to 59 feet. The median length was 40 feet, and the overall statewide average for the 62 vessels for which length data were available was 36 feet. As shown in Table 3.1, average vessel lengths were greatest on the island of Oahu (43 feet) and smallest on Maui (32 feet).

In terms of vessel age, charter boats comprising Hawaii's fleet ranged from 2 to 35 years of age assuming 1982 as the base year for age calculation purposes. The median vessel age was determined to be 4 years, and the overall statewide average age was 11 years. In Table 3.1, average vessel age is shown to be highest for Oahu (13 years) and lowest on Maui (9 years).

It is evident from Table 3.1 that the dominant form of propulsion used by Hawaii charter fishing boats is diesel or gas motors. The proportion of diesel to gas driven boats ranges from 33% on Kauai to 100% on Oahu. On a statewide basis, 88% of charter boats are diesel motor driven while 12% use gas engines.

3.1.3 Vessel Cost, Market Value and Remaining Useful Life

The reported purchase price of charter fishing boats ranged from \$750 to \$275,000. The median value was \$35,000 and the overall statewide average vessel cost was determined to be just under \$82,000 (see Table 3.2). As shown in Table 3.3, a majority of boat owners had purchased their boats from sellers in Hawaii, but this proportion varied considerably from island to island.

Owners generally reported that the market value of their boats had appreciated since purchase. This could be caused by a variety of conditions such as significant vessel improvements, increased market demand combined with a limited supply of suitable boats, or general price inflation. Maui-based fishing

Table 3.1 Characteristics of a Typical 1982 Charter Fishing Boat:
By Island and Statewide

Characteristic	Statewide	Hawaii	Oahu	Maui
Avg. Length (feet)	36	34	43	32
Median Year Built	1971	1972	1969	1974
Propulsion				
Diesel	88%	96%	100%	67%
Gas	12%	4%	0%	33%

Table 3.2 Average Purchase Price, 1982 Market Value, and Remaining Operating Life of Hawaii Charter Fishing Boats: By Island and Statewide

	Statewide	Hawaii	Oahu	Maui
Purchase Price (\$)	80,878	81,617	86,702	67,818
1982 Market Value (\$)	94,681	93,633	106,722	74,091
Remaining Operation Life (years)	12	14	13	9

Table 3.3 Percent of Respondents Indicating They Purchased Their Charter Boat Within the State of Hawaii: By Island and Statewide

Vessel Purchased in Hawaii?	Statewide	Hawaii	Oahu	Maui
Yes	60%	37%	80%	75%
No	36	63	20	17
No Response	4	0	0	8
TOTAL	100%	100%	100%	100%
N	73	30	25	12

boats were viewed by their owners to have experienced the lowest rate of appreciation (approximately 9% of initial cost), from a purchase price of \$67,818 to a 1982 market value of \$74,091. There was a consistent trend for the higher priced boats to experience more rapid rates of appreciation. For example, Oahu boat owners reported the highest purchase price, \$86,702, and reported the highest average rate of appreciation as well, 23% of the initial price of the vessel from \$86,702 to a 1982 market value of \$106,722.

Vessel remaining operating life, as viewed by the boat owner, ranged from 1 to 50 years. Boats operating out of the island of Maui were considered to have the shortest remaining operating life of 9 years. Big Island (Hawaii) boats were viewed by their owners to have the longest remaining operating life of 14 years. On a statewide basis, the average charter fishing vessel had a remaining operating life of 12 years in 1982.

3.2 Owner Characteristics

A total of 72 charter boat owners responded to the mail survey. The number of owners (72) is less than the number of boats (73) due to the fact that one owner provided information on 2 separate boats.

3.2.1 Demographic Characteristics

Demographic profiles of the 72 charter boat owners responding to the mail survey showed that the largest share of boat owners (41%) were found to live on the island of Hawaii. The island of Oahu was the second most prominent island on which charter boat owners resided (33% of respondents). Kauai and Molokai were the islands of residence for the fewest boat owners (4% and 3%, respectively). There were no respondents who lived on the islands of Lanai or Nihoa.

Socioeconomic characteristics of charter boat owners such as age, sex, education level and years of charter fishing experience were obtained by the survey to produce a more vivid picture of the "typical" Hawaii charter boat owner (Table 3.4). Age of owners ranged from 27 to 77 years. The median age was 40 and the overall statewide average age was determined to be 49 years. On an island basis, average age of owners was observed to vary between 40 years on Maui to 50 years on Hawaii and Oahu. For all islands, at least 91% of the owners responding to the mail survey indicated they were male. All survey respondents were high school graduates and approximately 13% of the survey group reported they had earned advanced graduate degrees.

Owners reported a wide range in the number of years they had been engaged in the charter fishing business. The average length

Table 3.4 Characteristics of an Average Charter Boat Owner in 1982:
By Island and Statewide

Characteristic	Statewide	Hawaii	Oahu	Maui
Age (Years)	49	50	50	44
Charter Experience (Years)	10	9	12	10
Sex (% Male)	97%	97%	100%	91%
Education (Years)	13	13	13	13

of experience was 10 years, and this average did not vary much across individual islands (Table 3.4). A more detailed breakdown of reported years of experience is given in Table 3.5.

Taken together, these findings suggest the following portrait of a charter boat owner in Hawaii. Typically, he is male, about 49 years old, has some college education and has been engaged in the charter fishing business for about 10 years. Furthermore, only slight differences exist in this profile between island groups. Hawaii and Oahu boat owners are slightly older, and those of Oahu are, in addition, slightly more experienced and all are male. There are slightly more women charter boat owners on Maui and in general Maui boat owners are younger than average too.

3.2.2 Motivations

The survey inquired about the motivations underlying Hawaii charter boat owners' participation in the charter fishing business. Respondents were asked to identify which of the following factors were primary motivators: "enjoy the life-style," "profitable," "enjoy meeting people," "only work I know," "tax shelter," "friends in business," and "other." The percentage of times a particular motivating factor was selected by respondents is summarized in Table 3.6. Looking first at the statewide results, it is clear that the typical Hawaii charter boat owner is most often motivated by the life-style associated with charter fishing as a primary reason for their participation in the industry. The second and third most often selected motives were "enjoyment of meeting people," and the "tax shelter" characteristics of a charter fishing business. Only 16% of the charter boat owners indicated that "profitability" was a primary reason for their participation in charter boat fishing. Lack of a strong profit motive in charter fishing is consistent with the finding that only 21% of the survey group claimed they were charter fishing for "tax shelter" advantages. The remaining motivational factors: "only work I know" and "friends in business," were deemed influential only by only a small fraction (3%) of the survey respondents.

Charter boat owners on different islands appear to be motivated by somewhat different factors. Of the survey respondents, owners residing on Maui least frequently indicated that enjoyment of the life-style associated with charter fishing was a reason for their participation in the business. For Oahu and Hawaii, enjoyment of life-style was mentioned 88% and 90% of the time by the charter boat owners residing on these islands, respectively.

The "enjoyment of meeting people" was the next most popular reason for being involved with the charter fishing industry. Again, Maui had the lowest percentage of respondents (25%)

Table 3.5 Years of Experience in the Charter Fishing Business as of 1982

Years of Experience	Number	Percent
1 to 3	14	19%
4 to 7	22	31
8 to 10	8	11
11 to 15	14	19
16 to 20	6	8
21 to 30	4	6
31 to 40	1	1
No Response	3	4
TOTAL	72	99(a)

(a) Deviation from 100% due to rounding error.

Table 3.6 Primary Motivating Factors for Participating in a Charter Fishing Business: By Island and Statewide

Motivating Factor	Statewide	Hawaii	Oahu	Maui
"Enjoy Life-Style"	85%	90%	88%	58%
"It's Profitable"	16	13	20	17
"Enjoy Meeting People"	55	73	44	25
"Only Work I Know"	3	3	0	8
"It's a Tax Shelter"	21	27	16	17
"Friends Are in Same Business"	3	3	4	0
"Other"	21%	10%	24%	25%
N	72	30	24	12

motivated by this otherwise popular factor. Owners from the islands of Oahu and Hawaii indicated this reason as a primary motive for their participation in charter fishing 44% and 73% of the time, respectively.

The remaining two motivating factors: "the only work I know" and "friends in same business," were viewed as important by only a very small percentage of charter boat owners.

The catch-all category of "other" reasons for being a participant in a Hawaii charter fishing business was indicated by a significant percentage of the charter boat owners for each island group. The most common unsolicited reasons supplied by the respondents were: "a way to make fishing affordable," and "establishing a business for a retirement occupation." Other motivating factors mentioned included: "owning a sporting goods store," "helps tourism," "born and raised in charter fishing," and one respondent simply stated "...it's a living."

3.3 Catch Characteristics

3.3.1 Catch Composition

The survey asked charter boat owners to identify the types and number of fish caught while charter fishing in 1982. The reasons for this were twofold. If fishery managers are to best manage Hawaii's marine resources, it is vital to have current data on the impacts which different user groups, in this case charter boat fishermen, have on various fish stocks. Information on catch was also needed to determine charter fishing revenues. Average catches for various fish species are reported in Table 3.7. Values for the average number of fish landed are drawn directly from catch data supplied by 57 respondents, while values for average landings in terms of weight are calculated using average fish poundage figures supplied by the National Marine Fisheries Service Honolulu Laboratory.

On average, vessels comprising Hawaii's charter fishing fleet landed 402 fish in 1982 weighing an estimated 18,516 pounds. In terms of numbers, two varieties of tuna, aku (Katsuwonus pelamis) and ahi (Thunnus albacares), dominated the Hawaii charter boat fish-catch. The most prominent is the aku, or skipjack tuna. A typical Hawaii charter boat landed 161 aku in 1982 out of a total of 402 fish caught for the year. Other prominent fish types landed were: mahimahi (Coryphaena hippurus), blue marlin (Makaira nigricans), ono (Acanthocybium solandri), and bottomfish. Also caught, but to a lesser degree, were shortbill spearfish (Tetrapterus angustirostis), striped marlin (Tetrapterus audax), shark (Carcharodon), ulua (Caranx Spp.), black marlin (Makaira indica), and barracuda (Sphyraena barracuda). The average Hawaii charter boat landed between 2 and 8 of these different fish types in 1982.

Table 3.8 Average Number of Various Fish Reportedly Caught During 1982 While Charter Fishing: By Island

Fish Type	Hawaii	Oahu	Maui
Aku	222	77	207
Ahi	36	42	130
Mahimahi	26	64	86
Ono	27	21	56
Ulua	(a)	2	8
Black Marlin	2	1	1
Blue Marlin	40	21	29
Sailfish	(a)	(a)	(a)
Shortbill Spearfish	9	5	10
Striped Marlin	7	8	8
Barracuda	2	2	2
Shark	6	2	30
Bottomfish	14	71	73
TOTAL	391	316	640
N	28	17	7

(a) Less than 1 fish.

Table 3.9 Charter Boat Owners' Perceptions About Their Customers' Preferences for Catching Different Types of Fish: By Island and Statewide

Fish Type	Highly Desirable	Somewhat Desirable	Somewhat Undesir- able	Very Undesir- able	No Response	Sample Size
Aku						
Statewide	14%	62%	11%	3%	11%	72
Hawaii	23	70	0	7	0	30
Oahu	4	64	16	0	16	24
Maui	0	67	17	0	17	12
Ahi						
Statewide	84	8	0	0	8	72
Hawaii	93	7	0	0	0	30
Oahu	80	8	0	0	12	24
Maui	75	17	0	0	8	12
Mahimahi						
Statewide	80	12	0	0	8	72
Hawaii	73	27	0	0	0	30
Oahu	88	0	0	0	12	24
Maui	83	8	0	0	8	12
Ono						
Statewide	58	30	1	1	9	72
Hawaii	63	30	3	3	0	30
Oahu	44	40	0	0	16	24
Maui	83	8	0	0	8	12
Ulua						
Statewide	21	43	8	6	23	72
Hawaii	17	53	8	10	13	30
Oahu	20	28	16	0	36	24
Maui	42	50	0	0	8	12
Black Marlin						
Statewide	82	4	0	0	14	72
Hawaii	97	3	0	0	0	30
Oahu	76	4	0	0	20	24
Maui	75	8	0	0	17	12
Blue Marlin						
Statewide	90	0	0	0	10	72
Hawaii	100	0	0	0	0	30
Oahu	84	0	0	0	16	24
Maui	92	0	0	0	8	12

Table 3.7 Average Number and Weight of Various Types of Fish
Reportedly Caught During 1982 While Charter Fishing

Fish Type	Average Number(a)	Estimated Average Poundage(a) (b)
Aku	161	1,127
Ahi	53	5,009
Mahimahi	44	572
Ono	28	518
Ulua	4	42
Black Marlin	2	550
Blue Marlin	30	6,750
Sailfish	(c)	188
Shortbill Spearfish	8	212
Striped Marlin	8	564
Barracuda	2	10
Shark	8	2,920
Bottomfish	54	54 (d)
TOTAL	402	18,516

(a) N = 57

(b) Average fish weight data obtained from statistics on charter vessel catches published by Hawaii Fishing News. Data represent simple averages of weights observed for the 1979 and 1980 fishing season.

(c) Less than 1 fish.

(d) Estimated to weigh 1 pound each.

In terms of weight, about 70% of the average vessel's catch is comprised of aku, ahi and blue marlin. Due to their smaller average weights, mahimahi are relatively less significant in terms of total catch poundage as they are in terms of total numbers of fish caught.

In grouping charter boat owners by their island of residence, those located on the island of Maui (N=7) had the overall largest number of fish caught (Table 3.8). Aku and ahi dominated the catch for Maui charterers. The remaining charter boat owners located on the islands of Hawaii and Oahu reported similar catch compositions as the statewide average and landed an average of 391 and 316 fish per boat in 1982, respectively.

The utility attributed to catching a particular game fish varies with the type and size of the fish being landed. Marlin have earned a reputation among sportfishermen as an excellent fighting fish. Attraction of sportfishermen to the challenge of landing a large marlin could go a long way in explaining why the island of Hawaii is the home of the bulk of the charter fishing fleet. As can be seen in Table 3.9, the island of Hawaii was the leader in marlin landings during 1982. This finding supports the general perception that the Kona coast is an excellent location for landing one of the most prized big game fish, the billfish.

An estimate of the magnitude of Hawaii's 1982 charter boat landings can be obtained in the following manner. By taking the average total number and poundage of fish caught by a typical charter boat in 1982 and multiplying it by the estimated size of charter fishing fleet (119), it is estimated that a total of 47,838 fish weighing 2.2 million pounds were caught by charter fishing patrons in 1982. This does not include any fish that were landed by charter fishing boats while commercial fishing without any paying passengers aboard. The 2.2 million pounds represents 15% of the total reported commercial fish landings for Hawaii in 1982 (USDC, 1983). The importance of charter catches for certain specific fish species is more pronounced. For example, the estimated blue marlin catch by the fleet (803,250 lbs) is 180% higher than the total commercial blue marlin catch reported in 1981 (DPED, 1982).

3.3.2 Desirability of Fish Types

Survey respondents were queried as to their perception of customer preferences for catching different types of fish. Their responses, tabulated on an island and statewide basis, are presented in Table 3.9. For each fish, respondents were asked to rank its particular level of desirability to charter patrons according to the scale: "Highly Desirable," "Somewhat Desirable," "Somewhat Undesirable," and "Very Undesirable." As

Table 3.9 Charter Boat Owners' Perceptions About Their Customers' Preferences for Catching Different Types of Fish: By Island and Statewide (continued)

Fish Type	Highly Desirable	Somewhat Desirable	Somewhat Undesirable	Very Undesirable	No Response	Sample Size
Sailfish						
Statewide	73%	6%	1%	0%	21%	72
Hawaii	10	83	3	0	0	30
Oahu	64	8	0	0	28	24
Maui	83	0	0	0	17	12
Shortbill Spearfish						
Statewide	48	36	4	0	12	72
Hawaii	53	37	7	0	3	30
Oahu	36	40	4	0	20	24
Maui	75	17	0	0	8	12
Striped Marlin						
Statewide	81	7	1	0	11	72
Hawaii	83	10	3	0	3	30
Oahu	76	8	0	0	16	24
Maui	92	0	0	0	8	12
Barracuda						
Statewide	5	38	25	14	18	72
Hawaii	7	40	23	27	3	30
Oahu	4	36	28	4	28	24
Maui	8	50	25	0	17	12
Shark						
Statewide	0	29	25	29	18	72
Hawaii	0	40	23	33	3	30
Oahu	0	24	24	24	28	24
Maui	0	25	25	33	17	12
Bottomfish						
Statewide	3	37	21	19	21	72
Hawaii	0	40	30	20	10	30
Oahu	4	28	20	16	32	24
Maui	8	58	0	17	17	12

indicated in the previous section, aku and ahi were identified as the fish most frequently landed by charter boats in 1982. Both of these types of tuna also happened to be considered desirable game fish by a majority of charter fishermen (Table 3.9). However, ahi was the more preferred of the two, with the majority of respondents indicating it was a "Highly Desirable" fish. No one indicated it was at all undesirable. Aku, while being considered desirable by most boat owners was viewed by majority of respondents to be only "Somewhat Desirable". A total of 14% of responding charter boat owners indicated that aku possess some undesirable characteristics. A possible explanation for this is the fact that the average ahi is a considerably larger fish than the average aku.

Fish types identified as being the most desirable to charter patrons were the various billfish. Most varieties of marlins were indicated as being "Highly Desirable" fish by more than 80% of the survey respondents and had no undesirable characteristics. The two exceptions to this were the sailfish and shortnose spearfish. The blue marlin was indicated to be the most desirable fish of all those listed.

Other fish types which were indicated to be desirable, but to a lesser degree than those previously mentioned, were ono and ulua. The two fish types which were considered to be more marginal in their desirability to patrons were bottomfish and barracuda. Taking the respective summed percentages of the desirable and undesirable categories, barracuda was indicated to be desirable by 43% and undesirable by 39% of the respondents. Sharks were observed to have the lowest desirability rating of any fish type listed. Summing the "undesirable" classification percentages obtained for sharks indicates that 54% of the charter boat owners perceived sharks to be an undesirable catch. Only 29% of all respondents indicated sharks as being "Somewhat Desirable." Sharks were the only fish type for which no respondents indicated it was "Highly Desirable."

In summary, the blue marlin is perceived by Hawaii charter boat owners to be the species most desired by their customers. The ranking order of fish types perceived to be the next most desirable are, in order of preference: ahi, black marlin, striped marlin, mahimahi, and the sailfin marlin. Of all the fish types listed in Table 3.9, sharks were considered to be the most undesirable.

3.4 Fishing Activity

3.4.1 Annual Trips and Passenger Loads

In the Hawaii charter fishing industry, four basic kinds of fishing trips are booked. Distinctions are made between

"private" and "share" charters, and between "full-day" and "half-day" charters. Private charters are booked in advance for parties ranging from one to six persons. A flat fee is charged for using the boat, which the contracting party is responsible for paying. Share charters, by comparison, involve groups of one to six unrelated persons who each pay a separate fee to go fishing. Since share charters are based on a per person fee arrangement, a minimum party size of three individuals is usually observed. Average party size observed for both half-day and full-day trips was 4 passengers. The difference between full-day and half-day charters lies in the duration of the fishing trip, and consequently in the areas fished. Both types of trips usually entail leaving port by 8:00 a.m. On a half-day trip, the customer is back in port by 1:00 p.m., while a full-day trip will extend to perhaps 5:00 p.m. Factors such as weather, port of departure, customers' fishing experience, and skipper preferences also influence the duration of charter trips.

Not all charter boats are engaged in both private and share charters, nor do all boats book both full-day and half-day fishing expeditions. On an average, however, it is estimated that in 1982 a representative charter vessel engaged in various charter fishing activities as shown in Table 3.10. Typically, 155 trips were provided in 1982. Due to the fact a portion was half-day trips, this trip load represented an average of 133 days of actual fishing activity. By far the bulk of activity was for full-day trips charters. This was also consistently observed on all islands. The difference between the number of share versus private charters was less distinct, but private charters definitely represented a majority of the average vessel's business.

In terms of customers serviced in 1982, it is estimated that the average vessel produced 620 passenger trips (155 trips x 4 passengers per trip). Expanding this to the entire fleet implies a total industry passenger trip output of 73,780 in 1982. As shown in Table 3.11, a large majority of these passenger trips were purchased by nonresidents of Hawaii.

Only on the island of Oahu was a sizable percentage of charter patrons residents of Hawaii. It was further determined that the bulk of charter boat business did not come from repeat customers (Table 3.12). This phenomenon was particularly evident for charter business operating out of tourist centers on Oahu and Maui.

In an attempt to estimate capacity utilization, vessel owners were asked how many additional days they were both willing and able to use their boat for charter fishing. The results, tabulated in Table 3.13, indicate that significant capacity under-utilization existed in 1982. On a statewide basis, total capacity is estimated to be 262 days of which only 51% was utilized. Capacity utilization ranged from a low of 41% on Oahu

Table 3.10 Average Number of Charter Fishing Trips Sold in
1982: By Trip Type

Trip Type	Average Number of Trips in 1982 (a)
Full-day Private	75
Half-day Private	23
Full-day Share	39
Half-day Share	18
TOTAL	155

(a) N = 35

Table 3.11 Percentage of Charter Fishing Passengers That Were
Nonresidents of Hawaii: By Island and Statewide

Percent Nonresident	Statewide	Hawaii	Oahu	Maui
Less than 25	8%	0%	16%	0%
25 - 49	1	0	4	0
50 - 74	4	7	4	0
75 - 99	71	83	68	58
100%	10	10	0	25
No Response	6	0	8	17
TOTAL	100%	100%	100%	100%
N	73	30	25	12

Table 3.12 Percentage of Charter Fishing Business From Repeat Customers in 1982: By Island and Statewide

Percent	Statewide	Hawaii	Oahu	Maui
0 - 24	48%	43%	52%	58%
25 - 49	25	27	24	25
50 - 74	16	20	16	0
75 - 99	1	3	0	0
100	0	0	0	0
No Response	10	7	8	17
TOTAL	100%	100%	100%	100%
N	73	30	25	12

Table 3.13 Average Number of Days Charter Fished, and Number of Additional Days Willing to Charter Fish in 1982:
By Island and Statewide

	Statewide	Hawaii	Oahu	Maui
Days fished	133	128	104	182
Additional days willing to fish	129	129	150	96
Excess Capacity	49%	50%	59%	35%
N	51	26	16	8

to a high of 65% on Maui.

3.4.2 Services Provided

The basic service provided in any charter fishing trip is the fishing experience itself. However, additional services are provided by various charter operations. The type and number of additional services depend upon the policy of each such operation.

Among the more common services provided are the fish handling services. Whereas charter operators do not perform the actual taxidermy, they provide the service of transporting fish to taxidermists. Fish cleaning is another frequently reported service offered by most charter operations. The least common service, in contrast, is providing free lunches or snacks to customers as part of the charter fishing trip. Table 3.14 displays the percentage of charter operations that provide various ancillary services.

3.4.3 Other Commercial Activities

In addition to deep-sea sport charter fishing, many of Hawaii's charter boat owners utilized their boats for commercial fishing purposes in 1982. As seen in Table 3.15, a majority of owners indicated they fished commercially in 1982. The proportion of vessels used for commercial fishing was greatest for the island of Oahu.

Table 3.16 describes levels of commercial activity other than commercial fishing undertaken by Hawaii's charter fleet in 1982. On a statewide basis, 53% of the respondents did not use their boat for anything beside fishing. The most frequent usage of boats for purposes other than fishing was party trips, which 18% of respondents confirmed having provided.

3.5 Employment

The average level of employment per charter boat based on 53 respondents, is given in Table 3.17. The average boat employed 1.21 persons full-time, 0.39 persons half-time, and 0.23 persons on a quarter-time basis. The average operation also employed on shore: 0.15 persons full-time, 0.06 persons half-time, and 0.25 persons quarter time. Converting these data into full-time equivalents reveals that the average charter operation employed about 1.7 persons full-time in 1982. Expanding this to the industry as a whole results in an estimated full-time work force of 203 workers. The actual number of people involved in the industry is of course higher than 203 workers because many employees work on a less than full-time basis.

Table 3.14 Percentage of Charter Fishing Operations Providing
Specific Services to Their Customers: By Island and
Statewide

Services	Statewide	Hawaii	Oahu	Maui
Fish cleaning	73%	90%	56%	67%
Transfer of fish to taxidermist	70	83	52	75
Fish cold storage	30	37	16	50
Free parking	38	63	16	25
Hotel pickup/ dropoff	43	77	20	8
Free lunch or snacks	7	7	4	8
Free beverage	18	23	12	17
N	73	30	25	12

Table 3.15 Extent of Commercial Fishing Activities by Charter Fishing Boats: By Island and Statewide

	Statewide	Hawaii	Oahu	Maui
Fished commercially	51%	40%	68%	33%
Average number of days	36	25	33	19
Did not fish commercially	42%	58%	24%	50%
No response	7%	3%	8%	17%
TOTAL	100%	101%(a)	100%	100%
N	73	30	25	12

(a) Deviation from 100% due to rounding error.

Table 3.16 Percentage of Vessels Engaged in Marine Commercial Activities Other Than Commercial Fishing in 1982:
By Island and Statewide

Activity	Statewide	Hawaii	Oahu	Maui
Tours	8%	3%	16%	0%
Research trips	5	13	0	0
Whale watching	7	3	4	25
Non-fishing party trips	18	7	32	25
Other	14	17	16	8
Boat not used for other activities	53	70	36	50
No response	14	0	20	17
N	73	30	25	12

Table 3.17 Average Number of Employees Per Charter Boat
Operation in 1982

Worker Class	On Boat(a)	On Shore(a)
Full-time (100%)	1.21	.15
Part-time (50%)	.39	.06
Part-time (25%)	.23	.25

(a) N = 53

3.6 Use of Fish Aggregating Devices

In the spring of 1981, the Hawaii Department of Land and Natural Resources (D.L.N.R.) deployed 26 "pentasphere" buoys around the eight main Hawaiian islands to act as fish aggregation devices (FADs). These buoys were deployed to replace the original "tire"-design FADs which were anchored in 1980 when the FAD deployment program was first initiated. Since that time, many user groups have utilized FADs as fishing locations and reportedly have enjoyed considerable fishing success around them. Approximately 900,000 pounds of game fish: aku, ahi, mahimahi, and billfish were documented as having been caught around FADs between April 1980 and April 1982 (Department of Land and Natural Resources, 1982). Given the general indication that FADs may provide benefits to user groups in the form of increased catches or decreased fishing costs, inquiries were made to determine the utilization of FADs by charter boat operators, and the benefits that these fishermen receive as a result of fishing near FADs.

The results from the mail survey suggested that FAD's are commonly used by Hawaii's charter fishing fleet. However, most (75%) charter boat operators visited FADs on less than 50% of their charter trips (see Table 3.18). There was one individual who indicated that 100% of his charter trips involved fishing within one-half mile of a FAD.

The percentage of total catch in 1982 that was caught within one-half mile of a FAD appears proportional to the level of fishing effort (number of trips taken) expended at these areas. It can be seen in Table 3.19 that, on a statewide basis, over 80% of the responding charter boat owners indicated that less than 50% of their catch was landed within one-half mile of a FAD. A majority (55%) indicated that a 0-24% of their catch was caught in areas adjacent to FADs.

Charter boat owners were asked to indicate which of their operating costs had been reduced due to utilization of FADs. Respondents were also asked to estimate the amount by which certain costs were reduced. The respondents used percentages to indicate the perceived reduction in cost for each item listed. The provided cost categories provided were: fuel and oil, labor, repair, gear, ice, and bait. Survey results for these questions are summarized in Table 3.20.

A total of 80% of the survey respondents indicated that their business did indeed experience a reduction in total costs as a result of fishing near FADs. On an average, reported total cost reductions were determined to be around 9%. The cost item which was identified most frequently as an expense that underwent reduction as a result of FAD fishing was fuel and oil. Fuel and oil savings were reported by over 50% of the survey respondents.

Table 3.18 Percentage of Charter Trips Taken in 1982 That
Involved Fishing Within 1/2 Mile of a FAD

Percent of Trips	Number	Percent
0 to 24%	32	44%
25 to 49	23	32
50 to 74	7	10
75 to 99	2	3
100	1	1
No response	8	11
TOTAL	73	101(a)

(a) Deviation from 100% due to rounding error.

Table 3.19 Percentage of Total Catch in 1982 That was Caught
Within 1/2 Mile of a FAD

Percent of Catch	Number	Percent
0 to 24%	40	55%
25 to 49	19	26
50 to 74	5	7
75 to 99	0	0
100		
No response	9	12
TOTAL	73	100%

Table 3.20 Cost Reduction Reported as a Result of Fishing
at FADs

Cost Item	Percent of Respondents Reporting a Reduction(a)	Average Percentage Reduction Reported
Fuel and Oil	53%	18.5%
Labor	4	.6
Repair	18	5.6
Gear	12	6.3
Ice	3	1.4
Bait	15	8.7
Total Costs	80	9.2

(a) N = 73

On an island basis, fuel savings were mentioned by as many as 80% of the respondents, for example on the island of Hawaii. The average reduction in costs for fuel and oil which can be attributed to utilization of FADs by a typical Hawaii charter boat operation was 19%. This factor alone amounts to approximately \$1,600 in annual savings for the average charter boat owner in Hawaii.

Expenditures for repairs were also commonly thought to be reduced due to the utilization of FADs. Eighteen percent of the survey respondents indicated a reduction in this cost item. On average, the degree by which repairs were reduced was 6%.

A third cost item thought to be reduced as a result of FAD fishing was bait purchases. Due to the behavioral characteristic of many baitfish to aggregate around flotsam, the reduced expenditure on bait was one which was anticipated. The indication of savings in bait cost was to some degree, predictable, however, the average percentage reduction for a typical charter operation was not. The statewide average was a 9% reduction in bait expenditures. On an island basis, it ranged from 5% for the island of Hawaii, up to a high of 15% for the average Oahu-based charter fishing operation.

Another way that FAD deployment might have provided benefits to charter fishing businesses is in somehow increasing demand for the services of charter fishing boats. To determine this, charter boat owners were asked to identify any increase in the number of customers over the past three years (length of FAD project) as a result of fishing near FADs. Approximately 23% of the survey respondents, on a statewide basis, indicated that they did indeed perceive such a change (Table 3.21). The owners who indicated that their business experienced an increase in charter customers reported an average increase of slightly greater than 10% (Table 3.22).

3.7 Comparison of Mail and Telephone Survey Responses

As previously noted, the characteristics of charter boats and owners described above were based on questionnaire responses of a sample of the relevant population. Whether characteristics of the sample are in fact representative of the entire population depends on characteristics of non-responding boat owners. To evaluate the representativeness of the 73 responding owners, a follow-up telephone survey of non-respondents was conducted during May, 1983. A new independent sample of thirty individuals was randomly selected from the ranks of mail questionnaire non-respondents, and surveyed by telephone. The telephone survey solicited information about owner and vessel characteristics, as well as about charter and non-charter fishing activity levels. Questions were worded in such a way as to replicate formats used in the mail survey.

Table 3.21 Change in Annual Number of Customers Over Last
Three Years as a Result of Fishing Near FADs

Customer Numbers Increased?	Number	Percent
Yes	45	62%
No	17	23%
No response	11	15%
TOTAL	73	100%

Table 3.22 Percentage Increase in Annual Number of Customers
Over Last Three Years as a Result of Fishing Near
FADs

Percent Increase	Number	Percent
0	10	14%
1 to 10%	7	10
11 to 20	3	4
21 to 30	2	3
31 to 40	0	0
41 to 50	0	0
51 to 60	0	0
61 to 70	0	0
71 to 80	1	1
81 to 90	0	0
91 to 100	0	0
No response	50	68
TOTAL	73	100%
Overall Mean Percent (N = 23): 11%		

Responses to seven questions included in both the mail and telephone survey groups were statistically compared by testing a series of hypotheses that the mean responses obtained for the two sample groups were identical. If the null hypotheses could not be rejected at a reasonable confidence level, then results obtained in the mail survey could be interpreted as being representative of the Hawaii charter fishing population. Results of seven pairwise t-tests are given in Table 3.23. In all tests, the null hypothesis that the mean values were the same across sample groups could not be rejected at a significance level less than 95 percent. The statistical difference between sample groups was detected to be most pronounced in the case of vessel age. The hypothesis that mean values were the same for vessel age could be rejected at the 90 percent significance level. However, the proportional difference in mean vessel ages was less than 10%. A large disparity, although statistically insignificant, was detected in average days of commercial fishing undertaken by the separate survey groups. These differences notwithstanding, the statistical test results generally support the outlook that the sample of charter boat operations under study here are reasonably representative of the entire Hawaii charter industry as it existed in 1982.

Table 3.23 Statistical Comparisons of Mean Values Observed for Selected Variables in Mail and Telephone Surveys

Variable	MAIL SURVEY		TELEPHONE SURVEY		Calculated T-Value (b) Ho: $\bar{X}_1 = \bar{X}_2$
	Mean Value Observed (a) $\bar{X}_1$	Standard Deviation S1	Mean Value Observed $\bar{X}_2$	Standard Deviation S2	
Length of Vessel (feet)	36.4 (67)	7.97	39.0 (22)	10.47	-1.2307
Year Vessel Built	1971.1 (66)	7.06	1967.32 (22)	13.59	1.7052
Days of Commercial Fishing	37.81 (31)	47.67	13.00 (2)	9.90	0.7245
Years of Experience	10.21 (70)	8.51	11.38 (8)	8.75	-0.3643
Owner's Age	48.74	11.78	48.75 (8)	16.08	-0.0030
Vessel Market Value (\$)	93,289.69 (68)	62,340.38	115,714.29 (7)	58,197.12	-0.9110
Vessel Purchase Price (\$)	79,672.37 (67)	59,193.40	87,666.67 (6)	41,745.26	-0.3227

(a) Number in parentheses indicates the number of observations used to calculate mean values.

$$(b) \quad T = \left[(\bar{X}_1 - \bar{X}_2) / \sqrt{[(N_1-1)(S_1^2) + (N_2-1)(S_2^2)]} \right] * \left[\sqrt{[(N_1*N_2)(N_1+N_2-2)] / (N_1+N_2)} \right]$$

4.0

CHARTER FISHING REVENUES AND COSTS

Measurements of annual revenues and expenses reported here are based on data collected by means of the mail questionnaire survey. In Table 4.1, estimates of revenues and expenses experienced by a typical charter operation in 1982 are given. These figures represent average values and consequently do not reflect variability in vessel costs and returns as it exists in the charter fishing population. A more detailed account of the charter fishing financial picture is as follows.

4.1 Operating Revenues

Charter fishing business operations generated revenues principally by the passenger fare structure imposed upon their customers. However, revenue was also generated by sales of fish caught while charter and commercial fishing, and by charging for services other than fishing trips.

4.1.1 Charter Fishing Revenues

Income received by charter boat owners as a result of providing various types of charter fishing trips is presented in Table 4.2, and is broken down into four service categories: half-day and full-day, share and private trips. The survey instrument provided data relating to the number of people taking a specific type of trip (i.e., half-day share, half-day private, full-day share, full-day private). The average number of trips (first column of Table 4.2) was derived by calculating for each boat the total number of people taking full-day or half-day trips. The resulting sums of people taking these two types of trips were divided by four, then divided by the number of respondents per island who provided charter activity data. By weighting the average number of full-day and half-day trips per island by the percentage of people that took share and private trips, it was possible to arrive at estimates of the average number of trips and type of trips per boat. For example, 14 respondents from the island of Hawaii yielded the following data: sum of people taking full-day private trips (ΣFDP) = 2838; sum of people taking full-day share trips (ΣFDS) = 1182. Thus the average number of trips full-day charter trips taken by boats on the island of Hawaii was determined to be: $[(2838 + 1182)/4]/14 = 72$. The average number of full-day private trips was calculated as: $[2838/(2838 + 1182)] \times 72 = 51$. Similar calculations produced the estimated values for number of trips reported in Table 4.2.

Estimates of charter fishing trip prices were likewise

Table 4.1 1982 Average Costs and Returns for Hawaii Charter Fishing
Boats: By Island and Statewide

	Statewide	Oahu	Hawaii	Maui
REVENUE				
1/2 day trips	\$ 9,739	\$ 3,645	\$ 9,180	\$ 24,471
Full day trips	39,066	53,746	25,992	42,780
Trips other than fishing	232	598	71	265
Sales from commercial catch	1,525	2,649	513	341
Sales from charter catch	17,703	21,238	16,006	34,688
TOTAL REVENUE	\$68,265	\$81,876	\$51,762	\$102,545
VARIABLE COST				
Fuel	\$ 7,990	\$10,183	\$ 4,866	\$ 12,590
Oil	401	550	236	430
Ice	980	1,783	409	751
Bait	375	459	303	671
Food	1,092	3,409	422	1,076
Beverage	756	1,478	534	1,075
Terminal tackle	1,027	797	1,378	1,612
Automobile	1,686	1,100	2,054	1,278
Repair (vessel & equipment)	4,786	5,408	4,177	5,804
Commission	2,709	2,215	2,950	3,791
Wages	17,660	19,295	15,949	21,089
Catch share	9,321	11,446	8,257	18,695
TOTAL VARIABLE COST	\$48,782	\$58,123	\$41,535	\$ 68,862
FIXED COST				
Depreciation:				
vessel	\$ 4,758	\$ 4,563	\$ 4,296	\$ 5,217
equipment	5,063	4,099	6,439	6,081
Insurance	2,572	2,769	2,328	2,399
Moorage	1,268	1,703	964	1,301
Haul-out	1,491	2,351	1,053	1,199
Booth rental	30	91	0	0
Advertising	1,304	1,379	1,413	959
Telephone	538	302	664	769
Utilities	234	195	146	573
Professional service	563	516	744	423
Association dues	50	14	90	20
License & Fees	147	30	224	255
Other expense	824	344	470	1,854
TOTAL FIXED COST	\$18,842	\$18,356	\$18,831	\$ 21,050
NET OPERATING INCOME	\$ 640	\$ 5,397	(\$ 8,591)	\$ 12,633
Interest expense	\$ 2,194	\$ 2,418	\$ 1,517	\$ 2,697
PROFIT/(LOSS) BEFORE TAXES	(\$ 1,554)	\$ 2,979	(\$10,108)	\$ 9,936

Table 4.2 Average Revenues Generated by Charter Fishing Activity:
By Island and Statewide

Type of Service (a)	Number of Trips	Price Per Trip	Revenue Per Boat	Revenue from Half-Day Trips	Revenue from Full-Day Trips
Statewide (n=35)					
HDP	23	\$245	\$ 5,635	\$ 9,739	\$39,066
HDS	18	228	4,104		
FDP	75	355	26,625		
FDS	39	319	12,441		
Oahu (n=13)					
HDP	15	\$243	\$ 3,645	\$ 3,645	\$53,746
HDS	0	120	0		
FDP	111	346	38,406		
FDS	59	260	15,340		
Hawaii (n=14)					
HDP	20	\$247	\$ 4,940	\$ 9,180	\$25,992
HDS	16	265	4,240		
FDP	51	354	18,054		
FDS	21	378	7,938		
Maui (n=6)					
HDP	48	\$248	\$11,940	\$24,471	\$42,780
HDS	59	213	12,567		
FDP	78	381	29,718		
FDS	42	311	13,062		

(a) HDP = Half-day Private; HDS = Half-day Share; FDP = Full-day Private; and FDS = Full-day Share.

extracted from the data collected on charter fares (Table 4.3). Prices for private charters were collected on a per trip basis, and prices of share charters were collected on a per person basis. The average share price per trip was obtained by multiplying the prices reported by four (again, based on the assumption of four passengers per trip). Estimated yearly revenues generated by the various types of trips are presented in Table 4.2, and appear as the first two revenue items on Table 4.1.

4.1.2 Fish Sales

Sales of fish caught while charter and commercial fishing were two other sources of revenue for charter operators. Estimates of revenues generated by charter catches, based on catch data, are presented in Table 3.7. The figures assume 100% catch retention by the charter boat (Table 4.4).

Revenue attributable to commercial fishing activity was estimated to be \$1,525 per charter boat in 1982. The estimate was derived by determining the proportion of charter operators that also fished commercially (51% statewide). Commercial catch averaged \$2,990 for boats that actually fished commercially. This figure was revised in order to estimate sales of commercial catch for a typical (or average) charter boat: $\$2,990 \times .51 = \$1,525$ per charter boat. Average values for commercial catch across islands were calculated in a similar manner.

4.1.3 Other Revenue

Just under half (49%) of the vessel owners surveyed reported receiving revenues in 1982 due to performance of services other than charter or commercial fishing. This includes revenues earned by providing tours, selling food and beverages, and the like. Questionnaire data yielded a total revenue figure of \$16,930 for 73 responding owners. Allocating this sum amongst the group resulted in an estimated \$232 per boat on a statewide basis.

4.2 Fixed costs

The fixed costs of charter fishing operation are defined as those costs that are incurred regardless of whether the vessel is used for commercial advantage, or not. Variable costs, in contrast, are incurred only as charter fishing or other commercial activity takes place. A breakdown of fixed cost estimates is given in Table 4.1. These figures represent industrial averages for 1982 and were derived as follows. The single largest fixed cost was depreciation, a non-cash expense. Straightline depreciation was used to calculate the cost of

Table 4.3 Average Prices Received for Full- and Half-Day Charter Fishing Trips, Both Share and Private Charters: By Island and Statewide

Type of Service	Statewide	Hawaii	Oahu	Maui
Full-day Share (\$)	80	94	65	78
Half-day Share (\$)	57	66	30	53
Half-day Private (\$)	245	247	243	248
Full-day Private (\$)	355	354	346	381
N	66	30	22	9

Table 4.4 Average Revenues Generated by Sales of Various Types of Fish Caught While Charter Fishing: By Island and Statewide

Fish Type	Statewide(a)	Hawaii(a)	Oahu(a)	Maui(a)
Aku	\$ 1,045	\$ 1,432	\$ 493	\$ 1,330
Ahi	7,513	5,117	5,897	18,442
Mahi	1,438	839	2,108	2,842
Ono	1,157	1,120	8,382	2,277
Ulua	49	9	18	98
Black Marlin	210	252	186	133
Blue Marlin	3,948	5,270	2,775	3,890
Sailfish	19	23	14	14
Shortbill Spearfish	210	250	143	272
Striped Marlin	772	691	809	760
Barracuda (b)	7	6	9	7
Shark	1,281	983	333	4,550
Bottomfish (c)	54	14	71	73
TOTAL	\$17,703	\$16,006	\$21,238	\$34,688

(a) Valuation based upon average weight of fish (Table 3.7); price per pound is ex-vessel price in 1980 (Hawaii Department of Aquatic Resources 1980 Catch Report) CPI adjusted to 1982 dollars (U.S. Department of Commerce, 1982).

(b) Average weight unavailable. Estimated to be 5 pounds per fish.

(c) Average weight and price unavailable. Estimated to weigh 1 pound per fish with price of \$1 per pound.

vessel depreciation. The average purchase price of a boat (and assuming no salvage value) was divided by the average useful life, in order to derive the annual depreciation costs. In fact, this represents an overstatement of actual depreciation due to the recent escalation of boat market prices. As noted in Section 3.1.5, most vessels have reportedly increased in value. Depreciation cost estimates for equipment were based on the assumption that the value of equipment assets is maintained at a constant level. Thus, it was assumed that reported purchases of new equipment represent a proxy measure for equipment depreciation as old equipment is replaced by new, so as to maintain capital investment in equipment intact.

Estimates of other fixed costs, unless otherwise stated, were obtained directly from survey data. The largest reported fixed cost item was vessel insurance. Average costs of insurance were similar across the state. Moorage fees ranged from an estimated low of \$964 in Hawaii to a high of \$1,703 on Oahu.

Estimated annual haul out cost was similar for Hawaii and Maui, but it was twice as much for Oahu. Closeness to dry dock facilities may prompt Oahu charter boat owners to haul out boats more frequently. Boats operating on islands other than Oahu may service their boats less frequently due to the distance of dry dock facilities.

Advertising costs were the next significant fixed cost. Estimates of average annual advertising expense ranged from a low of \$959 on Maui to a high of \$1,413 on Oahu. Interestingly, the relationship between the amount spent on advertising and the amount of revenue generated by charter trips on Oahu, Hawaii, and Maui appears to be negative.

Rental fees for booth space to house shore-based sales persons were a cost reported only on the island of Oahu. Telephone expense ranged from an estimated high of \$769 per year on Maui to a low of \$302 on Oahu. Utility costs were much higher on Maui in comparison with the other islands. The cost of accounting, legal, and other professional services ranged from \$744 on Hawaii to \$423 on Maui.

The cost of association dues were rather insignificant in 1982 ranging from \$3 to \$90 per year. Costs of licenses and fees varied from island to island. The average charter operation on Oahu spent \$30 on licenses and fees, while Maui and Hawaii operations ranged between \$220 to \$260.

4.3 Variable Costs

The rationale for segmenting fixed and variable costs in the manner depicted in Table 4.1, was to report as variable those costs that vary with the frequency of fishing vessel operations.

All variable cost estimates, unless otherwise stated, were obtained from survey data. Fuel and oil costs were the second largest costs incurred by charter boat operators. The island of Maui had the highest estimated combined fuel and oil expense of \$13,020 per year. Overall, estimated fuel cost varied directly with the type and frequency of trips.

Estimated cost of ice for the average charter operation was highest at \$1,783 per year on Oahu and lowest at \$409 per year for Hawaii. Estimated annual bait cost was highest for Maui-based boats and lowest at \$303 for Hawaii.

The cost of fishing line and lures (terminal tackle) varied from a low estimate of \$797 for Oahu to \$1,612 for Maui.

Variable costs for automobiles included fuel, repairs, and insurance for those charter operations that claimed an automobile as a business expense. The estimated cost ranged from a high of \$2,054 on Hawaii to a low of \$1,100 on Oahu.

Charter boat operations paid commissions to travel agencies, hotel activity centers, and other businesses that served as intermediaries in soliciting charter fishing patrons. Estimates of average commissions paid per charter boat ranged from a high of \$3,791 on Maui to a low of \$2,215 on Maui. Estimates of commission expenses were consistent with the magnitudes of revenue generated by charter trips on Maui and Kauai. However, the relationship between charter fishing activity and commissions paid for the average Oahu operation versus the average Hawaii operations was not consistent.

Payments to hired labor in the form of salaries, commissions and bonuses are depicted in Table 4.1 as "Wages." More specific data pertaining to statewide average labor expense are given in Table 4.5. The average total payroll per charter boat was calculated to be \$17,660. This figure accounted for all wages paid to captains, crew members and salespersons in the form of salaries, commissions, and bonuses.

The average labor payments as reported in Table 4.5 represent an average for both owner-operated and absentee-owned charter fishing operations. Owner-operated charter boats are those operations which did not report wages paid to captains. Absentee-owned operations are charter operations that reported payroll expenses for captains' salaries, commissions and/or bonuses. Fourteen of the fifty respondents were determined to be owner-operated fishing boats. The average payroll expense for owner-operated boats was \$6,156.28. Of this amount, \$5,224.14 was paid to crew member No. 1, \$89.29 to crew member No. 2, and \$842.85 to a salesperson. The average payroll expense for absentee-owner operations was \$21,657.67, of which \$13,636.25 was attributable to the captain's salaries. The average salary received by crew member No. 1 in this type of operation was

Table 4.5 Average Labor Expenses in 1982

Employee	Salary Paid (a)	Commission Paid (a)	Bonuses Paid (a)	Gross Income (a)
Captain	\$ 8,249	\$1,059	\$510	\$ 9,818
Crew member 1	5,305	875	424	6,604
Crew member 2	166	30	3	199
Crew member 3	46	95	0	141
Crew member 4	0	2	0	2
Salesperson 1	344	434	3	781
Salesperson 2	60	54	1	115
TOTAL	\$14,170	\$2,549	\$941	\$17,660

(a) N = 50

\$6,674.30; crew member No. 2 received \$236.86; crew member No. 3 received \$196.33; crew member No. 4 received \$2.83; salesperson No. 1 received \$752.77; and salesperson No. 2 received \$158.33. It is apparent, based on the average wages received by crew and salespersons, that the bulk of such workers are part time and must supplement their income via outside sources.

A portion of the sales value of fish caught on charter trips was often allocated to employees and served as compensation above regular wages. "Catch Share," the last item under variable cost in Table 4.1, was determined by means of utilizing charter catch revenue data found in Table 4.4 and making adjustments to reflect catch allocation proportions as indicated by the survey data. Data from the island of Maui is used to illustrate the procedure of estimating catch share as an expense to the charter operation. The data indicate that 60% of the charter operations on Maui were absentee-owned in 1982 (i.e., the captain was not the owner and was paid to run the boat). The remainder of boats (40%) were owner-operated. The allocation of catch by absentee-owned boats was 30.33% each to captain and crew. The allocation by owner operated boats was 43.75% to crew and the remainder to the owner/captain. Thus the calculated catch share expense for Maui was: $.6(2 \times .3033 \times \$34,688) + .4(.4375 \times \$34,688) = \$18,695$. The average estimated catch share expense was highest for Maui at \$18,695 and lowest for Hawaii at \$8,257.

4.4 Net Returns

On average, charter fishing vessels in Hawaii incurred an excess of operating revenues over operating costs in 1982. This excess amounted to \$640, or about 1% of total revenues. However, after deducting interest expenses, the typical charter operation incurred an estimated loss (before taxes) of \$1,554 in 1982. Vessels operating out of Maui reportedly generated the highest average profits in 1982, while Hawaii-based boats incurred the largest estimated average losses. Of those islands where boats were determined to be profitable on average, Oahu-based boats earned 3.6% on sales of \$81,876, and boats operating out of Maui earned 9.7% on sales of \$102,545.

Several factors were further investigated to help explain differences in average profit levels between islands, and between individual boats across the State. The first factor is the amount of days spent charter fishing in 1982. The influence of charter fishing activity levels on vessel profitability is most evident when comparing average charter revenues in Maui to those realized on Hawaii. The second factor is the form of vessel ownership. Whether the boat is owned and operated by the same person, or owned by an absentee owner can dramatically influence a boat's annual payroll.

A total of 51 respondents reported the actual number of days

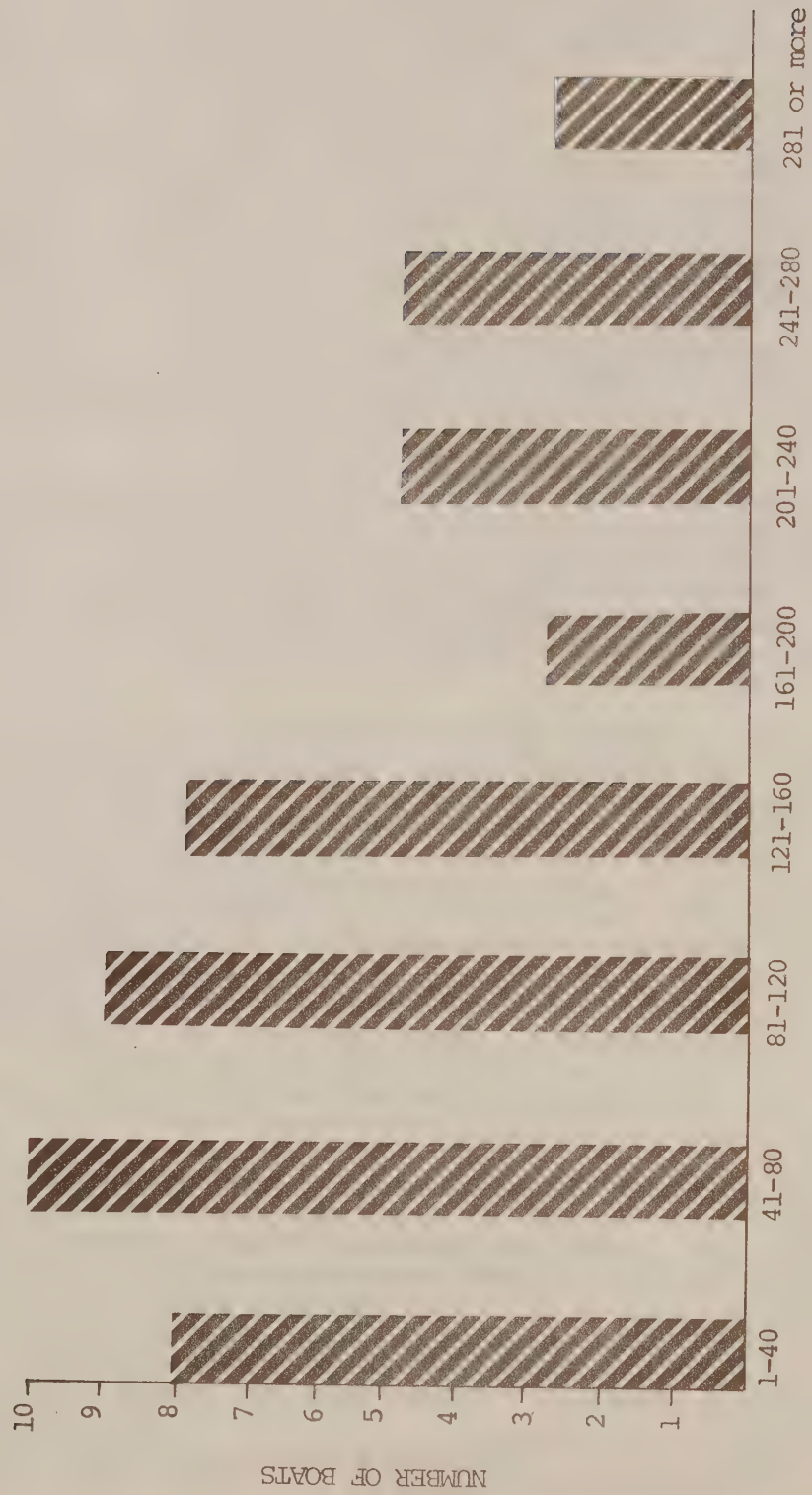
spent charter fishing in 1982. The average value for this subsample was 133 days. As seen in Figure 4.1, however, the distribution of reported charter fishing trip activity appears to be bimodal. Given this apparent difference, the subsample was divided into two groups depending on whether reported trips were greater than or less than 133. The estimated mean value for the group (N=24) taking more than 133 trips was 208 trips. The other group (N=27) averaged only 67 trips in 1982. A difference between means t-test was conducted, and the hypothesis that the average number of trips taken by the two groups were identical was rejected at the 95% significance level. Using average statewide revenue and cost data, it was further determined that the breakeven number of charter trips was equal to 128. Hence, it appears that approximately half the charter boats under study here were averaging less than the required charter trips needed to financially breakeven. An average charter frequency of 67 trips yields a loss of \$9,045 per year. By comparison, averaging 208 trips yields a calculated profit of \$11,588.

Averaging part-time and full-time boats together for purposes of estimating average profits is therefore somewhat misleading in the following sense. Although, all boats on average may be suffering losses, over half of the boats which are operated on a full-time basis may be making positive net returns. This in part helps explain the differences in average financial performance observed between islands.

Aside from variations in charter activity levels, sizable differences in reported wage payments were observed between charter boats. Out of a total of 50 respondents who supplied information on wage payments made in 1982, 36 (72%) indicated that wage payments were made to a captain or vessel skipper. By this fact, it was concluded that these vessels were not owner-operated. The remaining 14 (28%) owners did not make payments to a skipper, hence these individuals were classified as owner-operators. On average, absentee owners paid \$21,657 in total wages, commissions and bonuses, compared to \$6,156 for the typical owner-operator. Payments made to captains (averaging \$13,636) in large part explained the difference. Hence, all other things being equal, an owner-operator would expectedly save \$13,636 in costs compared to an average absentee-owner.

A simple cross tabulation was conducted to determine the geographic distribution of owner-operators and absentee-owners. The results are summarized in Figure 4.2. As expected, a direct relationship exists between average amount of wage outlays and proportion of vessels that are absentee-owned. However, the data suggests that despite higher wage costs, vessels owned by absentee owners sometimes fared better financially than owner-operated boats. For example, boats on Oahu were predominately owned by absentee owners. Yet compared to other islands (except Maui), Oahu-based boats exhibited relatively good financial performances on average in 1982. The opposite holds

Figure 4.1 Number of Charter Boats Engaged in Different Levels of Charter Fishing Activity



REPORTED DAYS OF CHARTER FISHING IN 1982

Figure 4.2 Observed Frequency of Absentee Owners and Owner-Operators: By Island



true for Hawaii, where a large proportion (75%) of boats were determined to be absentee-owned.

The frequency of charter fishing trips undertaken in 1982 is reported for owner-operators and absentee owners in Table 4.6. From these data it was determined that 69% of owner-operated boats are operating at less than breakeven trip levels, compared to 41% of the absentee-owned boats across the State. Thus, one may speculate that absentee-owned boats may tend to be operated more as serious business ventures compared to owner-operator vessels, but this certainly is not always the case.

5.0

COMPARISON WITH OTHER STUDIES OF CHARTER FISHING

It has been estimated elsewhere that in 1972, 2251 charter fishing boats (6 passengers or less) operated along the coasts of the United States (Centaur Management Consultants, Inc., 1977). During the same year, the industry created 1460 man years of employment and generated \$10.6 million in wages and incomes. What are the characteristics of this industry in terms of representative vessels and operations? How similar is the Hawaii charter fishing fleet to those that exist elsewhere? To answer these questions, a review of published studies on charter fishing was conducted. A search of the literature revealed seven separate studies conducted since 1970. These include investigations of charter fishing in Florida (Taylor, Prochaska and Cato, 1982), North Carolina (Manooch, Abbas and Ross, 1981), Washington (Crutchfield and Schelle, 1977), Texas (Ditton, Jarman and Woods, 1978), Georgia (Brown and Holemo, 1975), Wisconsin (Ditton, Strang and Dittrich, 1975), and Connecticut (Thursland, Altobello and Bender, 1983). Data for average or typical vessels reported in each of these studies are summarized in Table 5.1. All financial data have been adjusted to 1982 dollars using appropriate consumer price indices.

The similarities across the seven study areas including Hawaii, are remarkable. Average vessel ages are characteristically less than sixteen years. Most vessels are 30-45 feet in length and are manned by one full-time skipper and one part-time mate. Variation exists in average vessel value, but most are valued at less than \$100,000. Overall average vessel value is close to \$74,000. In terms of charter fishing activity levels, it would appear that many charter vessels are operated on a part-time basis, fishing less than 120 days per year. Operations in Hawaii and Florida benefit from moderate year round climates, and thereby charter 155 and 205 trips on average, respectively.

In terms of annual average financial performance, charter fishing operations nationwide appear to generate modest net returns. Operating revenues of less than \$50,000 along with high expenses for fuel, payroll, and insurance combine to keep average annual net returns below \$20,000. In short, the typical charter fishing operations appear to be small businesses, operated on a part-time basis and generating small profits.

Sizable cost differences were observed among fleets in different states. Contributing to cost differentials are differences in distances traveled to fishing areas, vessel and engine size, number of trips taken annually, age and make of the hull. This explains, for example, why fuel costs in Texas are 46% higher than those incurred by a typical charter boat in

Table 5.1 Overview of Characteristics of Charter Fishing Operations in the U.S.

	Florida (b) N = 19	North Carolina (c) N = 112	Washington (d) N = 200	Texas (e) N = 41	Georgia (f) N = 11	Wisconsin (g) N = 50	Connecticut (h) N = 25	Hawaii (i) N = 73
VESSEL CHARACTERISTICS: (a)								
Age (years)	13	16	8	(j)	(j)	(j)	13	11
Length (feet)	41	(j)	42	31	(j)	(j)	38	38
Crew Size (full-time)	(j)	(j)	1.3	1.6	(j)	(j)	2	1.9
Cost	\$71,062	(j)	(j)	(j)	(j)	(j)	\$66,284	\$80,878
Market Value	(j)	\$49,117	\$102,155	\$30,124	\$66,525	(j)	\$99,426	\$94,681
ACTIVITY LEVELS:								
Annual Half-Day Trips	156							
Annual Full-Day Trips	49							
Party Size	(j)							
ANNUAL COST/RETURN CHARACTERISTICS: (a)								
Operating revenues	\$53,849							
Fuel Costs	9,124	\$27,169	\$45,152	\$24,175	\$40,828	\$14,813	\$40,709	\$68,265
Moorage Costs	3,871	4,300 (1)	3,914	3,050	6,233	2,196 (1)	6,699	8,391 (1)
Commissions	1,375	745	770	963	2,825	544	663	1,268
Insurance Costs	1,767		4,960	59	1,274			2,709
Payroll	8,442	1,450	1,855	988		728	1,856	2,572
Other (m)	12,982	3,830	2,504	2,606	3,115	1,071	4,487	26,981
Net Return Before Depreciation,		7,501	11,433	4,394	6,668	3,479	7,193	15,883
Taxes and Interest	16,288	9,343	19,716	12,115	20,713	6,795	19,811	10,461
OWNER/OPERATOR CHARACTERISTICS:								
Age (years)	(j)	(j)	(j)	45		40	(j)	49
Sex (percent male)	(j)	(j)	(j)	(j)		100	(j)	97
Experience (years)	(j)	(j)	(j)	11.5		4	15	10

(a) All dollar amounts expressed in terms of 1982 (CPI adjusted) dollars, (U.S. Department of Commerce (1974-1982)).

(b) Taylor, Prochaska, and Cato (1982).

(c) Manooch, Abbas and Ross (1981).

(d) Crutchfield and Schelle (1977).

(e) Ditton, Jamman and Woods (1978); Ditton, Mertens and Schwartz (1978).

(f) Brown and Holeno (1975).

(g) Ditton, Strang and Dietrich (1975).

(h) Thursland, Altobello and Bender (1983).

(i) Based on mail survey results.

(j) Not available.

(k) Includes half-day trips.

(l) Includes oil costs.

(m) Includes expenses for repairs, ice, bait, food, advertising, property taxes, etc.

Hawaii. Other cost differences, for example in wage payments, result from structural differences in the way that charter businesses are typically organized. Relatively high wage payments in Hawaii stem from the fact that about half of the fleet is not owner-operated; compared to Texas and Wisconsin where almost all boats are owned and operated by the same individual or group of individuals. Other cost differentials can be attributed to differences in input costs between localities. Moorage is simply more expensive per foot in Hawaii than in Washington, for example. Finally, differences in observed outlays for such items as commissions and insurance are due to structural differences at the industry level. In Hawaii, charter sales are generated through a marketing network of hotel desks, tour organizers and charter boat associations. Hence, commissions are routinely paid to middlemen. By comparison, in Texas, charter referrals are given and received with little or no payment made.

While generalities about typical vessel characteristics are easy to make, it is equally important to note the large variances in vessel financial performance reported in each of the published studies. For example in Florida, charter fishing revenues for 19 boats averaged just under \$54,000. However, actual annual revenues ranged from \$0 to \$186,797. Similar wide variations in annual costs and net revenues exist in Florida, as well as elsewhere. Overall, profitability seems to be influenced by: 1) the distance charter boats must travel before beginning fishing; 2) proportion of clients who are repeat customers; 3) rate structure; and 4) frequency of trips taken each year. This large variability in financial performance levels raises doubts as to whether mean values correctly reflect the characteristics of the U.S. charter fleet. In fact, annual cost/return characteristics may be distributed bimodally. In North Carolina, for example, annual profitability of charter vessels is highly sensitive to home port. As a result, two distinct classes of charter vessels emerge. Similarly, in Florida, differences between part-time and full-time operators create statistically significant differences in the financial performance of the two groups.

Nevertheless, available average data on charter fishing operations elsewhere corroborate findings obtained in this Hawaii charter boat study. Available data suggest that there are more similarities than differences between charter fleets across the United States. Notable differences can be observed in operating costs and revenues, components and charter fishing activity levels. Important similarities exist in the size of the business in terms of sales, crew characteristics, vessel size and value, operator characteristics and motivations, and degree of profitability.

6.0

ECONOMIC IMPACT ANALYSIS

6.1 Overview of Measurement Techniques

In order to discuss economic impacts of charter boat fishing, one must first begin with the concept of Hawaii's economy as a system of producing and distributing wealth. A simplified model of such a system would have households supplying inputs to firms in the form of labor, and at the same time demanding goods and services produced by firms. Conversely, firms demand labor, while supplying goods and services. Thus, there arises a pattern of economic activity within Hawaii's island community.

Any change in an economy affects the patterns of economic activity, which in turn may have economic welfare implications. It is sometimes desirable to be able to determine the effects that certain economic activities have on various industries or on households. Estimating these effects is commonly referred to as economic impact analysis.

6.1.1 Input-Output Analysis

Economic impact analysis generally requires the construction of an Input-Output (I-O) model. A brief technical description of the modeling process is given in Appendix C. Essentially, an I-O model is a static representation of an economic region (for example, the State of Hawaii) at equilibrium. It depicts endogenous production and processing industries, as well as exogenous sectors that create final demands. Two basic components of an I-O model are the transaction or interindustry table and the technical coefficient table. Construction of I-O tables is based on three basic assumptions:

- 1) There is only one method used in producing each group of commodities and each sector has one homogeneous output,
- 2) Production relationships are linear in inputs and exhibit constant returns to scale over the relevant range of outputs for each sector,
- 3) There exist no external economies or diseconomies.

There are a number of alternative measures of economic impacts. The three typically discussed relate to impacts in terms of levels of output (sales), employment, and income. Each of these economic impacts are generally further measured in terms of Type I and Type II multipliers (Table 6.1).

In the case of measuring output or sales impacts, multiplier

Table 6.1 Alternative Economic Impact Measures

Economic Impact	Multiplier Name	Effect Measured	Value
Output (sales)	Simple (Type I)	direct + indirect	>1.00
	Total (Type II)	direct + indirect + induced	>Type I
Employment	Simple (Type I)	direct + indirect	>1.00
	Total (Type II)	direct + indirect + induced	>Type I
Income (wages)	Simple (Type I)	direct + indirect	>1.00
	Total (Type II)	direct + indirect + induced	>Type I

effects occur because of the high interdependence between industries and households in an economy. An industry, such as charter boat fishing, buys inputs which are required to produce an output: charter fishing trips. At the same time, it may supply goods and/or services which other industries require for their own productive activity. A plethora of interindustry transactions give rise to the simple (Type I) output multiplier. The rationale behind the existence of a Type I output multiplier for charter fishing is similar. If demand for charter fishing were to increase, charter boat owners would require inputs such as fuel, bait and ice from other industries to meet the new demand. Hypothetically, if there were a \$1 increase in the charter fishing sales, charter boat operators may have to increase their purchases from the retail section by \$.20 and from the manufacturing sector by \$.30 in order to meet this new demand. If the retail sector has to in turn increase its purchases from the manufacturing sector by \$.40 in order to meet the new demand placed on it due to the \$1 increase in charter fishing, the following multiple sales effect results: $\$1 + (.3(\$1) + .2(\$1)) + (.2(\$1).4) = \$1.62$. Thus, a \$1 increase in charter fishing sales eventually may give rise to a \$1.62 increase in sales through Hawaii's economy. The simple output multiplier in this case would be 1.62 and it measures the direct and indirect effects of a change in the demand for charter fishing. Multipliers can be viewed in two ways. On one hand, they measure the increased (multiplied) sales that would be generated within the whole economy due to an increase in demand for charter fishing. Alternatively, they represent the multiplied loss of sales that would be incurred due to a decrease in the demand for charter fishing.

Simple (Type I) output multipliers are calculated with households considered as exogenous sectors. Simple multipliers do not take into account the added requirement of labor needed in order to meet the new demand. When households are considered as endogenous to the system, a larger multiplier called a total or Type II multiplier is derived. In addition to measuring the direct and indirect effects, the Type II accounts for induced economic effects. Induced effects arise because industries also require additional labor to meet an increase in final demand. Accompanying any increased labor purchases is additional economic activity as wages are respent on goods and services. Type II multipliers will always be larger than corresponding Type I multipliers.

Employment is another economic impact which will be studied. The total employment multiplier is the change in the total employment in an economy resulting from a one unit change in employment of a particular sector. For example, if the Type II employment multiplier associated with charter fishing is 1.2, it would imply that by hiring one more person, the charter fishing industry generates an additional .2 jobs within the whole economy due to indirect and induced effects. The mechanics of

calculating this multiplier are similar to output multiplier calculations.

In addition to changes in output and employment, there may be interest in changes in household income that would result from changes in demand for charter vessel services. Total changes in income, like output, can be calculated in two ways. The first method takes into account both the direct and indirect effects. The multiplier estimated is called the Type I income multiplier (the analog of the simple output multiplier). Type II income multipliers are more realistic because they account for the induced changes in income resulting from increased consumer spending (Miernyk, 1965).

Computation of the Type I income multiplier requires data of direct, as well as direct-plus-indirect income changes. A direct income change is that portion of income that goes directly to households as wages, salaries and dividends due to an increase in output of a particular industrial sector. The Type II income multiplier is simply the Type I multiplier plus the induced effect created by treating the household sector as endogenous.

6.1.2 Alternative Approaches

Estimating total output, employment, and income impacts associated with charter fishing activity in Hawaii can be approached from several ways. For example, the economic impact of recreational fishing in Hawaii, both onshore and offshore, has been studied by Hoffman and Yamauchi (1972). In this study, the economic impact of recreational fishing was evaluated in terms of a Keynesian income multiplier rather than using I-O calculations. Their procedure involved using published data to construct a fishing expenditure function which explicitly accounted for import leakages. A modified income multiplier (modified because it corrected for input leakages) was then calculated from published data. Specifically, the income multiplier used by Hoffman and Yamauchi was expressed as follows:

$$\text{Total income increase} = A/(1-BC)$$

where A = angler expenditures remaining in local area
 B = marginal propensity to spend disposable income locally
 C = proportion of expenditures that accrues as local income.

The term $1/(1-B)$ is the familiar Keynesian multiplier, and the parameters A and C are included to adjust for leakages. Calculation of the income multiplier depended upon the values of parameters B and C. A value for B (.77) was obtained from an empirical study published in 1971 (Ghali and Renaud, 1971). A value of C (0.5), was obtained from a 1960 study (FHB, 1960). Thus an income multiplier of $1/(1 - (0.77)(0.5)) = 1.63$ was

calculated.

Total increase in income due to recreational fishing expenditures was calculated as $A \times 1.63$. The functional value of A was derived from the 1960 FHB study as:

$$A = .419t + .498v + .419f$$

where t = total transportation cost
 v = total additional living costs
 f = total cost of fishing equipment

Values for t , v , and f were obtained by means of a mail survey. Substituting the estimated values into the formula for A yielded a total economic impact of \$11.5 million.

Numerous other studies relating to economic impacts of fishing have been conducted outside of Hawaii. Callaghan and Comerford (1978), for example, measured the economic impacts of commercial fishing on the State of Rhode Island during 1975. Their methodology involved constructing a regional I-O model. The types of fishing industries represented in the interindustry transactions matrix of their model included: fin-fish catching; lobster catching; mollusk catching; fish handling, packing, and processing; non-Rhode Island vessels; and a sector called "other economic activity." Data for the transaction table necessary for I-O analysis was derived from various sources. Survey data obtained from a questionnaire addressed to fishermen supplied the bulk of the information. Total output multipliers were calculated from each type of fishing industry. A multiplier of 4.24 was calculated to represent the overall commercial fishing impact on the economy of Rhode Island. Type I and Type II income multipliers were also calculated for each type of fishing industry.

An alternative method of assessing economic impact for fishing activity was conducted by Reiling, Cook, and Taylor (1982) in an investigation of recreational ice fishing in Maine using a questionnaire survey. Ice fishermen's expenditures were calculated from a questionnaire survey and then were allocated to three sectors - wholesale and retail trade, transportation, and services. Output multipliers for each of these sectors were obtained from the Regional Economic Analysis Division, U.S. Department of Commerce. Direct impact was reported as the actual expenditures spent in the three sectors. Indirect impact was calculated as being the direct impact multiplied by the corresponding adjusted sector specific gross output multipliers minus one. A total impact of \$20 million was reported as the sum of the direct and indirect impacts. Analysis of economic impacts in terms of employment and income was not reported.

6.2 Procedure Adopted

The decision to base the present charter fishing economic impact study on a methodology other than that utilized by Hoffman and Yamauchi hinges on the lack of necessary data. The relevancy and applicability of data over 10 years old to this present study is highly questionable. Another factor is that the Hoffman and Yamauchi study expressed the income multiplier as a function of expenditures of fishermen. The present charter fishing study considers this relationship, but also accounts for the fact that charter fishing vessels supply intermediate goods to the economy in terms of fish landings. Also, charter boats sell a service which directly impacts the State's economy while recreational fishing does not. The rationale for rejecting the Maine ice fishing economic impact assessment methodology is based on similar difficulties.

The Rhode Island commercial fishing study derived multipliers by way of I-O analysis. The investigators constructed an interindustry transaction table which represented purchases and sales between the various industries. Manipulation of the table allowed calculations of the various multipliers. Since the charter fishing industry purchases its inputs from other industries and sells its output (charter services and the fish caught) to other economic sectors, a methodology similar to the Rhode Island fishing study was employed for purposes of this study.

The Department of Planning and Economic Development (DPED), State of Hawaii, maintains an interindustry I-O model of the State's economy. The model is derived from National I-O studies, and surveys of Hawaii's firms conducted by the DPED and the University of Hawaii. For modeling purposes, the economy of the State is disaggregated into 20 industries each of which is represented in the interindustry transaction matrix of the model. Since charter fishing is a small industry, it is not represented as a separate sector. Consequently, it is not possible to obtain multipliers for charter fishing activities directly from DPED reports.

The present study involved modifying the State's model to include an additional industry -- charter boat fishing. Thus, a modified 21 industry I-O model was created. The task was accomplished by separating charter fishing activities out of one of the industries defined in DPED model. After discussions with DPED economists, consensus was reached that charter fishing had been included in the industry titled "OTHER AGRICULTURE" in the DPED model. It then became a matter of determining charter fishing purchases and sales and subtracting that amount from the amount reported in "OTHER AGRICULTURE," thereby preserving the overall production interdependency of industries implied in the model.

Estimates of charter fishing purchases and sales were developed based on primary data collected by the survey. Table 4.1 presents estimated purchases and sales of a representative charter boat in Hawaii. These data were expanded to accommodate the 119 charter boats (as estimated by the survey) in order to derive estimates for sales and purchases of the entire fleet. Industry-wide sales and purchase figures were then allocated into existing industries as specified in the DPED I-O model. Table 6.2 represents the allocation after two major adjustments were made based on 1) the final demand sector of the National Bureau of Economic Analysis I-O model which yields coefficients for industry of origin (Regional Economic Analysis Division, 1977), and 2) estimated import coefficients for Hawaii. These modifications, using data provided by the DPED, did not affect the total amount of sales and purchases by various sectors, but merely redistributed sales and purchases among the industries and sectors in the model so as to reflect as accurately as possible the transactions between industries and leakages from the system. The reallocation procedure might best be illustrated with an example. Fuel and oil were major purchases made by the charter fishing industry, but are not specific industry categories in the State's I-O model. The reallocation process involved allocating fuel and oil purchases according to percentages that typical industries consume petroleum products. The Bureau of Economic Analysis coefficients for industry of origin indicate, for example, that 61% of fuel and oil purchases are attributable to the miscellaneous manufacturing industry, 3% to the transportation and warehouse industry, 21% to the wholesale, and 15% to the retail industry. Similar adjustments for other charter fishing purchases were made. The import coefficients were utilized in order to adjust purchases to account for the fact that not all goods and services were manufactured locally and their value implicitly has imported "value added" included in them. Survey data revealed that the charter fishing industry imported an estimated \$285,838 worth of goods and services directly. After making necessary adjustments to reflect ultimate origins of purchased goods, the estimated amount of imports became about \$1 million and the estimated amount of local purchases was necessarily decreased by an identical amount. The fully modified interindustry transaction table and technical coefficient table are given in Appendix D.

6.3 Multiplier Estimates

6.3.1 Sales Multipliers

The Type I sales multiplier for the charter fishing industry was estimated to be 1.46. This implies that, because of interindustry linkages between charter activity and other industry activities, every \$1.00 sales in charter fishing industry is associated with \$1.46 worth of sales or output in the entire economy. The direct effect of \$1 sales in the charter

Table 6.2 Estimated Industry-Wide Purchases and Sales by the Charter Fishing Fleet

Sales to:

Food Processing	\$ 762,711	
Eating & Drinking	762,711	
Personal Consumption	1,929,791	
Tourist	4,668,322	
		\$8,123,535

Purchases from:

Other Agriculture	\$ 57,820	
Other Food Process	116,620	
Miscellaneous Manufacturing	575,650	
Transp./Warehs.	341,798	
Communication	64,022	
Elect., Gas, & Sanit.	27,846	
Wholesale Trade	126,554	
Retail Trade	98,306	
Banking & Finance	639,744	
Health and Prof.	222,173	
Other Services	615,468	
Household	3,210,739	
Other Value Added	967,946	
Imports	1,058,849	
		\$8,123,535

fishing industry is a \$1 increase in the State's economy. The indirect effect is the additional \$.46 that arises because of the recurrent spending generated as a result of interindustry linkages or dependency.

Type I sales multipliers are discussed less frequently than Type II multipliers. Type II multipliers, because they include the household sector as a contributing element in the economy, present a more realistic synopsis of input and output relationships. The charter fishing industry Type II sales multiplier was calculated to be 2.3423. This Type II multiplier includes the same effects at the Type I multiplier plus the additional effect which is induced when wages are received by households then recirculated in the economy.

Thus the direct impact on the State of Hawaii in terms of sales or output is the \$8,123,535 estimated to have been generated by the charter fishing industry in 1982. Due to indirect impacts arising from interindustry linkages, it is calculated that charter fishing generates \$11,860,361 ($8,123,535 \times 1.46$) in direct and indirect sales. The direct plus indirect plus induced effect of charter fishing sales is estimated to be \$19,035,067 ($8,123,535 \times 2.3432$).

6.3.2 Income Multipliers

The Type I income multiplier ((direct + indirect income change)/direct income change) is the direct and indirect income generated by \$1 additional direct income. In the case of charter fishing, the Type I income multiplier is 1.406 ($.55572/.39524$). The direct income impact of charter fishing is \$3,210,739, the amount paid out in the form of wages and compensation for labor to households. The direct and indirect impact on the economy is \$4,514,299 ($\$3,210,739 \times 1.406$), this being attributable to interindustry linkages and the additional jobs charter fishing supports indirectly.

The Type II income multipliers ((direct + indirect + induced income change)/direct income change) is similar to the Type I multiplier but includes the additional induced effect of household respending. The charter fishing Type II income multiplier was calculated to be 2.2688 ($.89672/.39524$). The economic impact based on the Type II income multiplier is \$7,284,525 ($\$3,210,739 \times 2.2688$).

6.3.3 Employment Multipliers

Direct employment attributable to charter fishing is estimated to be 203 workers (119 boats $\times$ 1.705 person per boat). Employment multipliers were calculated using an estimate of the average wage paid per employee and the direct, indirect and

induced income effects expressed above. Data relating average wage paid per employee in Hawaii was not available. Using the DPED's 1981 average wage of \$14,471 and inflating it by 5% (a conservative estimate based on historic increases of wages), the average in 1982 wage becomes \$15,195.

Charter fishing's indirect income effect is \$1,303,560 (4,514,299 - 3,210,739) implying that charter fishing supports \$1,303,560 worth of wages in industries other than itself. This figure divided by the estimated average wage per worker in 1982 yields an estimate of the number of people indirectly being employed due to charter operations. Thus charter fishing supports 85 workers indirectly along with 203 workers directly involved in the business, implying a Type I employment multiplier of 1.4236 $((203 + 85)/203)$.

The Type II employment multiplier is calculated in a similar manner. The indirect and induced income effect of charter fishing is \$4,073,786 (\$7,284,525 - \$3,210,739). Dividing the indirect and induced income by the average income per worker in 1982 yields an estimated 268 workers employed. The Type II employment multiplier is calculated to be 2.32 $((203 + 268)/203)$.

The Type I multiplier expresses the direct and indirect employment generated for each additional job in the charter industry. The Type II multiplier encompasses a similar reasoning but with the added induced effect. Note that \$40,017 (\$8,123,535/203) of charter sales are implied to support 1 job in the charter fishing industry, the inverse of this number is the technical requirements' coefficient for workers in the charter industry (i.e., every \$1 of sales it requires .000024989 workers).

6.3.4 Summary of Economic Impacts

Table 6.3 presents a summary of the various multipliers, and estimated impacts based on survey data. These data represent a relationship between charter fishing and the entire economy. An illustration may perhaps serve to highlight the significance of this relationship. Suppose there had been a \$100,000 increase in sales in the charter fishing industry. This increase might have been generated in a variety of ways. For example, suppose more fish were caught or perhaps more tourists took charter trips. While charter fishing industry itself would have increased its sales by \$100,000 directly, total sales output for the entire State's economy would be augmented by \$146,000 $(100,000 \times 1.46)$ because of interindustry sales linkages. When the induced effect of household activity is included, an additional \$100,000 in charter fishing sales translates into \$234,230 $(\$100,000 \times 2.342)$ worth of output to the State.

Likewise, this increased sales imply \$39,524 $(\$100,000 \times$

Table 6.3 Summary of Economic Impact Multiplier for Charter Fishery in Hawaii

Economic Impact	Direct Impact	Direct + Indirect Impact(a)	Direct + Indirect + Induced Impact (a)
Sales	\$8,123,535	\$11,860,036(1.46)	\$19,009,072(2.34)
Income	\$3,210,739	\$4,514,299(1.406)	\$7,288,377(2.27)
Employment	203 workers	288 workers(1.423)	471 workers(2.32)

(a) Numbers in parenthesis are estimated multiplier values.

.39524) of additional wages paid to labor as more workers are brought into the market in order to meet the increased demand. Based on the direct and indirect effect, this income figure inflates to \$55,571 ($39,524 \times 1.406$). The total effect on the State as calculated by the Type II income multiplier is \$89,672 ($39,524 \times 2.2688$) worth of wages and salaries paid to households in the State due to a \$100,000 increase in charter fishing sales.

The impact of \$100,000 increase in charter fishing sales on employment can be traced in a similar manner. There would be a direct increase in employment of 2.5 ($100,000 \times .000024989$) workers. The direct and indirect effect on the State's employment would be 3.56 (2.5×1.4236) jobs created, but because there is also an induced effect, the total impact would be 5.8 (2.5×2.32) jobs created in the entire economy.

It is also illustrative to compare the economic impact of charter fishing in Hawaii with other marine industries, and with the total State economy. The fleet generated an estimated \$8.1 million in total revenue in 1982, mainly from sales of charter fishing trips and commercially caught fish. Indirect and induced sales amounted to an additional \$8 million. Estimated charter fishing direct sales compare closely with sales volumes estimated for the surfshop industry in Hawaii of \$9.1 million (Miller, 1984) and are about 20% higher than the \$6.7 million of retail sales generated by Hawaii's diving industry (van Poollen, 1983). Compared to total 1982 sales made in the State of Hawaii (\$20,722 million), direct charter sales represent about .03% (DPED, 1983).

The industry directly employed 203 people (full-time basis) in 1982, and indirectly created an additional 269 full-time positions as a result of purchases from other economic sectors. In terms of direct employment, charter fishing activities in the State created 240% more positions than the scuba industry that employed 84 people on a full-time basis (van Poollen, 1983). Out of a total 1982 statewide employment level of 442,350, the charter fishing industry was directly responsible for about .04%.

7.0

ATTITUDES OF CHARTER FISHING VESSEL OWNERS

Charter fishing--like most other industries--has its share of bottlenecks and other problems that limit the profitability of individual operations, and constrain industrial expansion. Most charter boat owners have formed diverse personal opinions about what the major problems facing the industry are, and how the State and Federal governments can constructively assist industrial expansion. It is possible, however, to obtain a general idea about what owners think has enhanced or retarded growth of charter fishing in the State. With this goal in mind, survey respondents were polled about their attitudes concerning a range of potentially relevant issues. The results of the poll, discussed below, represent the opinions of active members of Hawaii's 1982 charter fishing fleet. Unrepresented are the views of inactive members, charter fishing operation that have previously failed, and those that began operations since 1982.

7.1 Management Concerns

Respondents were asked to identify the single greatest problem facing Hawaii's charter fishing industry. Respondents were given a list of five problems to chose from. Survey results are tabulated in Table 7.1. First, all boat owners responding to this series of questions agreed that there are definite problems besetting the industry. This conclusion is suggested by the failure of any respondents to select the response "no problems" on their questionnaires. On a statewide basis, respondents most frequently indicated that "operating costs too high" as the single most important problem. In view of the relatively poor financial performance of the industry in terms of profitability, this outlook is understandable. Existence of high operating costs was most often viewed as problematic on most islands, except on Molokai and Hawaii, where "inadequate facilities" was more frequently mentioned.

Lack of adequate harbor facilities was another popularly perceived problem. However, as can be seen in Table 7.2, the majority of boat owners believed that harbor facilities have not deteriorated. Apparently, they must think that port facilities have never been satisfactory. Harbor improvements were most commonly noted on Hawaii, and harbor facility degradation was reported most often on Molokai. This disparity in outlooks reflects the geographic distribution of harbor improvement activities by the U.S. Army Corp of Engineers and the Hawaii Department of Transportation over the past two decades. A further glimpse of the harbor facility problem is evident in Table 7.4, with particular reference to the inquiry about lack of berthing space. Overwhelmingly, boat owners agreed that lack of

Table 7.1 Respondents' Attitudes About the Single Greatest Problem Facing the Charter Fishing Industry in Hawaii: By Island and Statewide

Problem (a)	Statewide	Hawaii	Oahu	Maui
Inadequate Facilities	16%	20%	4%	17%
Lacking Government Support	15	13	16	25
Insufficient Effort in Advertising/Marketing	10	20	4	0
Insufficient Promotion for Tourism	12	13	16	8
Operating Cost Too High	23	7	32	33
Other	7	7	4	17
No Problems	0	0	0	0
No Response	16	20	24	0
TOTAL	99%(b)	100%	100%	100%
N	72	30	24	12

(a) This list of potential problems was suggested to respondents.

(b) Deviation from 100% due to rounding error.

Table 7.2 Respondents' Attitudes About How Harbor Facilities
for Charter Fishing Have Changed During the Past
5 Years: By Island and Statewide

Option	Statewide	Hawaii	Oahu	Maui
Improved	27%	50%	16%	8%
Unchanged	38	37	40	50
Worsened	33	13	44	33
No Response	1	0	0	8
TOTAL	99%(a)	100%	100%	99%(a)
N	72	30	24	12

(a) Deviation from 100% due to rounding error.

berthing space creates limits on the growth of charter fishing. This is consistent with other reports that have identified berthing space limitations as a bottleneck to commercial fisheries expansion in Hawaii (e.g., see Department of Land and Natural Resources, 1979).

A third commonly perceived problem was "lack of government support." This outlook is consistent with the owners' majority opinion that the State government has done little to encourage growth of the industry (Table 7.3). In fact, a slight majority of owners shared the attitude that the Government had discouraged growth. The negative image assigned to the State government is not directly interpretable from survey data. However, some clues can be found in Table 7.4. One way that the State influences the industry is through fish stock management. By far the majority of owners on a statewide and island basis (except Molokai) viewed fisheries management from a positive perspective. Thus, the State's role in fisheries management is probably not the problem, nor is the State's installation of FADs view as a problem. Evidence presented above, as well as findings pertaining to owners' views on FADs (Table 7.4) all support the conclusion that FADs are popular with charter boats. Therefore, it is suspected that the owners' opinions about the State government are based primarily on the failure of the State to live up to the industry's expectations concerning harbor infrastructure development and improvement.

7.2 Informational Needs

Over 90% of boat owners on all islands identified at least one informational need. As can be seen in Table 7.5, information relating to industry catches, vessel insurance, and marketing and advertising was most frequently deemed to be needed. Informational needs tended to vary considerably between islands.

With the exception of Oahu, a majority of anglers on other islands indicated that a statewide charter fishing association would be useful (Table 7.6). Furthermore, willingness to join and pay annual dues to such an organization was relatively high (Table 7.7). A potential benefit of participation would be increased recognition for the industry and as improved information exchange.

Table 7.3 Respondents' Attitudes About Hawaii State Government's
Policy Toward Growth of Hawaii's Charter Fishing Industry:
By Island and Statewide

Option	Statewide	Hawaii	Oahu	Maui
Encourages Growth	8%	10%	12%	0%
Indifferent	44	43	36	50
Discourages Growth	45	47	48	42
No response	3	0	4	8
TOTAL	100%	100%	100%	100%
N	72	30	24	12

Table 7.4 Respondents' Attitudes About Specific Management Issues Relating to Charter Fishing: By Island and Statewide (a)

Statement	Strongly Disagree	Probably Disagree	Probably Agree	Strongly Agree	No Response	N
Lack of berthing space creates limits on the growth of charter fishing in Hawaii.						
Statewide	8%	12%	48%	29%	3%	72
Hawaii	10	20	47	20	3	30
Oahu	8	4	32	52	4	24
Maui	8	17	67	8	0	12
Management of offshore fish resources in Hawaii is more likely to help my charter fishing business than hurt it.						
Statewide	4%	7%	58%	29%	3%	72
Hawaii	10	3	60	23	3	30
Oahu	0	8	48	40	4	24
Maui	0	8	67	25	0	12
Often there are too many boats at good fishing locations to allow for successful trolling.						
Statewide	19%	33%	22%	25%	1%	72
Hawaii	30	27	23	20	0	30
Oahu	4	40	24	28	4	24
Maui	17	33	8	42	0	12
Commercial fishing by others does not significantly reduce my annual catch.						
Statewide	19%	18%	22%	38%	3%	72
Hawaii	17	23	17	40	3	30
Oahu	24	12	28	32	4	24
Maui	17	8	17	58	0	12

Table 7.4 Continued

Statement	Strongly Disagree	Probably Disagree	Probably Agree	Strongly Agree	No Response	N
If on average my boat caught one less fish per month, it would not significantly lower demand for my charter fishing services.						
Statewide	16%	12%	30%	38%	3%	72
Hawaii	13	23	33	27	3	30
Oahu	12	8	32	44	4	24
Maui	25	0	25	50	0	12
Even if my customers do not catch any game fish, they still seem to enjoy the experience of fishing.						
Statewide	1%	14%	25%	59%	1%	72
Hawaii	0	7	30	63	0	30
Oahu	4	24	16	52	4	24
Maui	0	17	17	67	0	12
My customers <u>prefer</u> fishing around <u>Fish Aggregating Buoys</u> compared to fishing in the open ocean away from buoys.						
Statewide	4%	30%	34%	27%	4%	72
Hawaii	7	17	53	20	3	30
Oahu	0	48	16	32	4	24
Maui	0	33	33	25	8	12
Often congestion from other boats around Fish Aggregating Buoys is so bad that it reduces chances of catching fish.						
Statewide	16%	16%	23%	42%	1%	72
Hawaii	23	17	20	40	0	30
Oahu	12	8	32	44	4	24
Maui	8	33	17	42	0	12

Table 7.4 Continued

Statement	Strongly Disagree	Probably Disagree	Probably Agree	Strongly Agree	No Response	N
I experience more gear loss around Fish Aggre- gating Buoys than when I fish away from buoys.						
Statewide	41%	30%	10%	18%	1%	72
Hawaii	50	27	17	7	0	30
Oahu	32	20	8	36	4	24
Maui	33	58	0	8	0	12

(a) Phrasing of the question was: "How do you personally feel about each of the statements below? For each statement, circle the response which is closest to the way you feel." The percentages reported on this table represent the frequency that a particular response was observed.

Table 7.5 Types of Published Business Information Reported to be Useful to Charter Boat Owners: By Island and Statewide

Types of Information	Statewide	Hawaii	Oahu	Maui
Catch Data	62%	67%	64%	42%
Marketing/Advertising	66	73	60	67
Other Charter Operations	37	43	28	33
Dollar Value of Charter Fishing to Community	51	70	40	33
Dollar Value of Charter Fishing to State	38	57	28	25
Cost of Typical Operation	52	57	44	50
Vessel Insurance	70	77	56	67
Marine Safety	41	43	44	25
Other	3	3	4	0
Not Interested in Any	4%	3%	8%	0%
N	72	30	24	212

Table 7.6 Respondents' Attitudes About the Usefulness of a
Statewide Charter Fishing Association: By Island
and Statewide

Useful	Statewide	Hawaii	Oahu	Maui
Yes	58%	67%	32%	83%
No	38	33	56	17
No Response	4	0	12	0
TOTAL	100%	100%	100%	100%
N	72	30	24	12

Table 7.7 Respondents' Reported Willingness to Join and Pay Annual Dues to a Charter Fishing Association in Return for Representation and Information: By Island and Statewide

Willing to Join?	Statewide	Hawaii	Oahu	Maui
Yes	54%	63%	32%	75%
No	16	20	20	0
No Response	30	17	48	25
TOTAL	100%	100%	100%	100%
N	72	30	24	12

8.0

CONCLUDING REMARKS

This report has explored the physical and operating characteristics of Hawaii's charter boat fishing industry as it existed in 1982. However, information assembled here can also be used to predict the expected financial viability of the industry over the next decade.

Financial prospects for the charter boat fishing industry in Hawaii hinge closely on future demand and supply circumstances. Consider first the demand outlook. Survey data suggest that charter boat clientele are predominantly nonresidents of Hawaii. A reasonable assumption is that the size of this particular group is positively related to the total amount of visitors coming to Hawaii. Historically, visitor arrivals (both eastbound and westbound) have increased at an average annual rate of 6% (DPED, 1982). It can therefore be anticipated that nonresidents' demand for charter boat services will grow somewhat accordingly. The exact relationship, of course, depends on the demographic profile of new visitors in terms of disposable income and ethnic origin. It also depends on their preferences for offshore sport fishing experiences, and on their knowledge about the quality of charter boat fishing in Hawaii.

Quite likely demand for charter fishing trips by Hawaii residents will similarly increase over time. Assuming no change in per capita demand (for example, due to changes in income or changes in recreational fishing preferences), total demand by residents should increase roughly in accordance with the average annual population growth rate of about 1.5% (DPED, 1982). Use of more effective advertising could probably stimulate this growth rate even higher.

While the demand outlook appears promising, the supply situation, is less encouraging. A primary source of concern is the overwhelming over-capacity of the existing fleet. Currently, an estimated 119 boats comprise the fleet. Many are operated on a part-time basis, at less than 50% capacity utilization. This phenomenon extends to all islands, even those with burgeoning numbers of out-of-state visitors. If a 49% average excess capacity estimate is used, this implies that the existing fleet is capable of delivering twice as many charter fishing trips as it currently does. Yet, given the slow growth rate in the total market (6 percent or less), an effective doubling of demand will take decades to occur. Hence, excess capacity will exist far into the future, even if no additional boats join the fleet. However, this raises another issue. Namely, as long as entry into the fleet is relatively unrestricted, it is doubtful that the fleet size will remain constant in response to growing demand. It is possible that additional capacity will be

forthcoming at a rate that leaves total capacity utilization at its current relatively low level. This outlook is supported by three observations. First, it is evident that charter fishing businessmen are not strongly profit-oriented. They engage in the activity for other personal, non-financial reasons. Thus low profits cannot be expected to discourage potential entrants. Second, investment requirements are relatively low, and do not serve to effectively limit participation in the industry. Finally, no other significant barriers exist to entry such as trade associations, strict industrial marketing controls, or direct government controls on fleet size. The only effective constraint is berthing shortages, and ironically the industry as a whole would like to see this constraint relaxed!

Taken together, supply and demand projections indicate fairly steady growth in sales by the charter fishing industry as a whole in response to increased demand by both resident and nonresident anglers. Accompanying this growth in the total market will be increments to the total fleet size. This, in turn, will create additional jobs, income, and indirect sales impacts. Yet, all this will occur in a financial environment that leaves the average boat still barely able to make a before-tax profit.

9.0

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APPENDIX A

MAIL QUESTIONNAIRE SURVEY INSTRUMENT

SPECIAL HAWAII CHARTER FISHING SURVEY

IT IS IMPORTANT THAT THIS QUESTIONNAIRE BE FILLED OUT BY THE PERSON TO WHOM IT IS ADDRESSED.

PLEASE TRY TO ANSWER EACH QUESTION SINCE A SINGLE MISSING ANSWER WILL DECREASE THE VALUE OF ALL YOUR OTHER ANSWERS. ANSWER WHAT YOU BELIEVE IS TRUE FOR YOU. THE BEST ANSWER IS THE ONE WHICH MOST CLOSELY REFLECTS YOUR OWN FEELINGS OR WHAT YOU ACTUALLY DID.

WE REALIZE THAT YOUR CHARTER FISHING BUSINESS MAY HAVE BEEN QUITE ACTIVE IN 1982, AND YOU MAY FIND IT DIFFICULT TO REMEMBER EXACT DETAILS ABOUT THE 1982 CHARTER FISHING SEASON. THESE DETAILS, HOWEVER, ARE VERY IMPORTANT TO THE SUCCESS OF THE SURVEY. PLEASE TAKE THE TIME TO THINK BACK OR CHECK YOUR RECORDS. FOR CERTAIN QUESTIONS, YOU MAY WANT TO ASK YOUR SKIPPER OR CREW TO GET THE CORRECT INFORMATION. TRY YOUR BEST TO ANSWER ALL QUESTIONS AS ACCURATELY AS POSSIBLE.

THE QUESTIONNAIRE HAS BEEN DIVIDED INTO SECTIONS TO MAKE IT EASIER FOR YOU TO COMPLETE.



THANK YOU FOR YOUR HELP

IN THIS SECTION WE ARE INTERESTED IN LEARNING HOW YOU PERSONALLY FEEL ABOUT A VARIETY OF ISSUES RELATING TO CHARTER FISHING. WE STRESS THAT ALL OF YOUR ANSWERS ARE STRICTLY CONFIDENTIAL.

1. Do you believe local harbor facilities for charter fishing have changed in any way during the last 5 years? (CHOOSE ONE)

_____ Local harbor facilities for charter fishing have improved over the past 5 years.

_____ Local harbor facilities for charter fishing have neither improved nor gotten worse over the past 5 years.

_____ Local harbor facilities for charter fishing have gotten worse over the past 5 years.

2. In your opinion, what is the Hawaii government's policy towards the growth of Hawaii's charter fishing industry?

_____ The Hawaii government has encouraged the growth of the charter fishing industry.

_____ The Hawaii government has discouraged the growth of the charter fishing industry.

_____ The Hawaii government has neither encouraged nor discouraged the growth of the charter fishing industry.

3. The primary reason(s) I am in the charter fishing business is because: (CHECK ALL ANSWERS THAT ARE TRUE FOR YOU)

_____ I enjoy the life-style.

_____ It is profitable.

_____ I enjoy meeting a variety of people.

_____ It is the only work I know.

_____ It is a tax shelter.

_____ My friends are in the same business.

_____ Other (please specify).

4. How do you personally feel about each of the statements below?
For each statement, CIRCLE THE RESPONSE WHICH IS CLOSEST TO THE
WAY YOU FEEL.

SD-Strongly Disagree
pd-probably disagree

SA-Strongly Agree
pa-probably agree

Lack of berthing space creates limits on the growth of charter fishing in Hawaii.	SD	pd	pa	SA
Management of offshore fish resources in Hawaii is more likely to help my charter fishing business than hurt it.	SD	pd	pa	SA
Often there are too many boats at good fishing locations to allow for successful trolling.	SD	pd	pa	SA
Commercial fishing by others does not significantly reduce my annual catch.	SD	pd	pa	SA
If on average my boat caught one less fish per month, it would not significantly lower demand for my charter fishing services.	SD	pd	pa	SA
Even if my customers do not catch any game fish, they still seem to enjoy the experience of fishing.	SD	pd	pa	SA
My customers <u>prefer</u> fishing around <u>Fish Aggregating Buoys</u> compared to fishing in the open ocean away from Buoys.	SD	pd	pa	SA
Often congestion from other boats around Fish Aggregating Buoys is so bad that it reduces chances of catching fish.	SD	pd	pa	SA
I experience more gear loss around Fish Aggregating Buoys than when I fish away from Buoys.	SD	pd	pa	SA

5. What types of published information on Hawaii's charter fishing fleet would you find useful to your business? (CHECK ALL ANSWERS THAT ARE TRUE FOR YOU)

☐ Catch data.

☐ Marketing/advertising.

☐ Charter operations in Hawaii ports other than mine.

☐ Dollar value of charter fishing to my community.

☐ Dollar value of charter fishing to the state.

☐ Costs of typical charter operations.

☐ Vessel/charter insurance.

☐ Marine safety.

☐ Other (Specify) _____

☐ I am not interested in information on Hawaii's charter fishing fleet.

6. Do you think a statewide charter fishing association would help you business?

☐ YES

☐ NO

If yes, would you join the association and pay annual dues in return for representation and information?

☐ YES

☐ NO

7. What is the single greatest problem for the charter fishing industry in Hawaii? (CHOOSE ONLY ONE)

☐ Lack of facilities (slips, scales, etc.).

☐ Lack of government support for the charter industry.

☐ Not enough advertising/marketing effort.

☐ Not enough tourist industry promotion.

☐ Operating costs too high.

☐ Other (Please specify) _____

☐ There are no problems facing Hawaii's charter fishing industry.

IN THIS SECTION WE ARE INTERESTED IN LEARNING ABOUT THE AMOUNT AND TYPES OF FISH WHICH YOUR CHARTER FISHING BOAT LANDED IN 1982.

1. For each of the kinds of fish given below, please give the total number of fish which your boat landed while charter fishing in 1982. Do not include any fish which were landed while commercial fishing (no customers aboard) or while fishing only for fun.
(FILL IN THE BLANKS WITH THE CORRECT AMOUNTS)

Number of fish caught while
charter fishing in 1982

AKU	_____
AHI	_____
MAHI	_____
ONO	_____
ULUA	_____
BLACK MARLIN	_____
BLUE MARLIN	_____
SAILFIN MARLIN	_____
SHORTNOSE MARLIN	_____
STRIPED MARLIN	_____
BARRACUDA	_____
SHARK	_____
BOTTOMFISH	_____

2. Your charter customers probably enjoy catching some kinds of fish more than others. For each of the kinds of fish listed below, please indicate what your customers think about catching this type of fish while charter fishing on your boat. (CIRCLE ONE ANSWER FOR EACH TYPE OF FISH)

	HD-Highly Desirable		su-somewhat undesirable	
	sd-somewhat desirable		VU-Very Undesirable	
AKU	HD	sd	su	VU
AHI	HD	sd	su	VU
MAHI	HD	sd	su	VU
ONO	HD	sd	su	VU
ULUA	HD	sd	su	VU
BLACK MARLIN	HD	sd	su	VU
BLUE MARLIN	HD	sd	su	VU
SAILFIN MARLIN	HD	sd	su	VU
BARRACUDA	HD	sd	su	VU
SHARK	HD	sd	su	VU
BOTTOMFISH	HD	sd	su	VU
SHORTNOSE MARLIN	HD	sd	su	VU
STRIPED MARLIN	HD	sd	su	VU

IN THIS SECTION WE ARE INTERESTED IN LEARNING HOW MONEY PASSES THROUGH THE CHARTER FISHING INDUSTRY INTO HAWAII'S ECONOMY. PLEASE SUPPLY INFORMATION FOR THE YEAR 1982. AGAIN, WE REASSURE YOU THAT YOUR RESPONSES WILL BE HELD IN THE STRICTEST OF CONFIDENCE.

1. Sometimes fishermen purchase equipment, supplies, and materials from out of state sources. This would involve direct mail orders, transactions through friends on the Mainland, or any other transaction that do not go through local merchants. How much did you spend in 1982 on items purchased directly from supply sources outside of Hawaii?

\$_____ was spent in 1982 on outside purchases.

THE REST OF THE QUESTIONS IN THIS SECTION DEAL WITH LOCAL PURCHASES ONLY.

To help you remember your operating costs, we have divided this question according to per trip, monthly, and yearly basis. Please check your records for exact amounts whenever possible, or give your best estimate for each category. Enter a zero "0" if the item was not an expense in 1982. PLEASE DO NOT INCLUDE OUT OF STATE PURCHASES.

2. PER TRIP COSTS FOR 1982

What were your average expenses for the following items on a typical full day versus a typical half day trip in 1982? Please fill in the blanks with the average amount of money spent. Place a zero "0" in the blank if an item was not purchased in 1982.

<u>EXPENSE</u> <u>ITEM</u>	<u>AVERAGE AMOUNT SPENT PER TRIP</u> <u>IN 1982</u>	
Fuel	\$_____ per full day trip	\$_____ per half day trip
Oil	\$_____ per full day trip	\$_____ per half day trip
Ice	\$_____ per full day trip	\$_____ per half day trip
Bait	\$_____ per full day trip	\$_____ per half day trip
Food	\$_____ per full day trip	\$_____ per half day trip
Beverage	\$_____ per full day trip	\$_____ per half day trip

3. MONTHLY COSTS FOR 1982

Please report your expenditures per month in 1982 for the following cost items. Enter a zero "0" if the item was not an expense in 1982.

<u>MONTHLY EXPENSE</u>	<u>AMOUNT SPENT</u>
<u>ITEM</u>	<u>PER MONTH IN 1982</u>
Payment on boat	\$_____ per month
Lures	\$_____ per month
Fishing line	\$_____ per month
Moorage	\$_____ per month
Advertising (phone book, printing, etc.)	\$_____ per month
Telephone	\$_____ per month
Utilities	\$_____ per month
Auto Expenses (if auto considered a business expense):	
Fuel	\$_____ per month
Repairs	\$_____ per month
Auto payments	\$_____ per month
Insurance	\$_____ per month
Rental of on-shore booths	\$_____ per month
Other (Please Specify)	\$_____ per month

4. COSTS PER YEAR FOR 1982

Please report the amount you spent in 1982 in order to meet the following expenses or make the following purchases. Enter a zero "0" if the item was not an expense in 1982.

<u>YEARLY EXPENSE ITEM</u>	<u>AMOUNT SPENT IN 1982</u>
Boat insurance	\$ _____ in 1982
Licenses & fees (Coast Guard, commercial, etc.)	\$ _____ in 1982
Legal & professional service (accountants, lawyers, etc.)	\$ _____ in 1982
Association dues	\$ _____ in 1982
Fishing equipment	
Nets	\$ _____ in 1982
Rods	\$ _____ in 1982
Gaffs	\$ _____ in 1982
Reels	\$ _____ in 1982
Coolers	\$ _____ in 1982
Vessel Improvements	
Boat covers	\$ _____ in 1982
Safety equipment	\$ _____ in 1982
Communication equipment	\$ _____ in 1982
Navigation equipment	\$ _____ in 1982
Cold storage installation	\$ _____ in 1982
Engine Repair (including rebuilding)	\$ _____ in 1982
Electronic equipment repair	\$ _____ in 1982
Fishing tackle repair	\$ _____ in 1982
Other maintenance & repair (excluding haul-out)	\$ _____ in 1982
Tournament fees	\$ _____ in 1982

6. We are also interested in the level of employment by the Charter Fishing Industry. Please report the number of people your charter business employed in 1982. If you shared dock-side reservations or a sales booth with other boats, please report that portion to the salespersons service which you actually paid for.

Number of Employees in 1982		
	On Boat	On Shore
Full-time (100%)		
Part-time (50%)		
Part-time (25%)		

7. In what year did you purchase the boat you used in 1982 for charter fishing?

The boat was purchased in the year _____.

8. Did you purchase the boat in Hawaii? Please check one.

_____ YES

_____ NO

9. Please indicate the price you paid for your charter fishing boat.

I paid \$ _____ for my boat when I purchased it.

10. In your opinion, what was the market value of your boat in 1982?

The market value of my boat in 1982 was \$ _____.

11. How many more years could your boat be used for charter fishing?

_____ years.

<u>YEARLY EXPENSE ITEM</u>	<u>AMOUNT SPENT IN 1982</u>
Commissions (to travel agency, hotel activity centers, airlines, etc.)	\$_____ in 1982
Marine hardware	\$_____ in 1982
Tools	\$_____ in 1982
Haul-out to repair hull	\$_____ in 1982
Other	\$_____ in 1982

5. Labor is one of the costs incurred in running a business. Please give the amount you paid in 1982 to meet labor expenses. Enter a zero "0" if the item was not an expense in 1982.

Employee:	Salary Paid in 1982	Commission Paid in 1982	Bonuses Paid in 1982
Captain			
Crew member 1			
Crew member 2			
Crew member 3			
Crew member 4			
Crew member 5			
Crew member 6			
Salesperson 1			
Salesperson 2			

IN THIS SECTION WE ARE INTERESTED IN LEARNING ABOUT YOUR CHARTER FISHING ACTIVITIES DURING 1982.

1. During 1982, what port(s) did you operate your charter fishing business out of? (FILL IN THE BLANKS WITH THE NAME OF YOUR HOME PORT(S))

_____ Port #1

_____ Port #2

_____ Port #3

2. During 1982, how many people took full-day and half-day private charters aboard your fishing boat? (FILL IN THE BLANKS WITH THE CORRECT AMOUNTS)

A total of _____ people took full-day private charters aboard my charter boat in 1982.

A total of _____ people took half-day private charters aboard my charter boat in 1982.

3. During 1982, how many people took full-day and half-day share charters aboard your fishing boat? (FILL IN THE BLANKS WITH THE CORRECT AMOUNTS)

A total of _____ people took full-day share charters aboard my charter boat in 1982.

A total of _____ people took half-day share charters aboard my charter boat in 1982.

4. How many days did you use your boat for charter fishing in 1982? (FILL IN THE BLANK WITH THE CORRECT AMOUNT)

_____ Days

5. How many additional days would you have been willing and able to use your boat for charter fishing if you had more customers in 1982? (FILL IN THE BLANK WITH YOUR ESTIMATE)

_____ Additional Days

6. What share of the people who took charter fishing trips with you in 1982 were non-residents of Hawaii? (CHOOSE THE ANSWER THAT IS MOST TRUE FOR YOU)

_____ All of my charter passengers in 1982 were non-residents.

_____ 75% to 99%

_____ 50% to 74%

_____ 25% to 49%

_____ Less than 25%

7. What do you typically charge for a private and share full-day and half-day of charter fishing? (FILL IN THE BLANKS WITH THE CORRECT AMOUNT)

\$ _____ is my typical full-day charge per person for share charter fishing.

\$ _____ is my typical half-day charge per person for share charter fishing.

\$ _____ is my half-day charge for private charters.

\$ _____ is my full-day charge for private charters.

8. During 1982, fish that were landed by your charter fishing boat were either kept by your customers and crew, or were sold. On average, what share of your total fish landings was kept by your customers and crew and not sold by you. (CHOOSE THE ANSWER THAT IS MOST TRUE FOR YOU)

_____ Between 75% and 100% of my boat's 1982 fish landings were kept by customers or crew and not sold by me.

_____ Between 50% and 74%

_____ Between 25% and 49%

_____ Between 0% and 24%

9. When you sell fish which are caught during charter fishing trips, how are the fish sales revenues distributed between owner, skipper and crew? (FILL IN THE BLANKS WITH THE CORRECT AMOUNTS)
- _____ % of fish sales revenues went to the boat skipper in 1982.
- _____ % of fish sales revenues went to the crew in 1982.
- _____ % of fish sales revenues went to the vessel owner in 1982.
- _____ I did not sell any of the fish caught while charter fishing.
10. Did you use your boat for commercial fishing in addition to charter fishing in 1982? (CHOOSE ONE)
- _____ Yes, I used my boat for commercial fishing in 1982.
- _____ If yes, approximate number of days fished in 1982 _____.
- _____ No, I did not use my boat for commercial fishing in 1982.
11. What were your total revenues in 1982 from commercial fish sales? DO NOT INCLUDE SALES OF FISH THAT WERE CAUGHT WHILE CHARTER FISHING. (FILL IN THE BLANK WITH THE CORRECT AMOUNT)
- \$ _____ of commercial fish sales were made in 1982.
- _____ I did not use my boat for commercial fishing in 1982.
12. What commercial activities, other than charter and commercial fishing, was your boat used for in 1982? (CHECK ALL ANSWERS THAT HOLD TRUE FOR YOU)
- _____ Tours
- _____ Research trips
- _____ Whale watching
- _____ Party trips (non-fishing)
- _____ Other (please specify)
- _____
- _____
- _____ I did not use my boat for other commercial activities.

13. What income did you receive in 1982 from use of your boat for commercial activities other than charter and commercial fishing? (FILL IN THE BLANK WITH THE CORRECT AMOUNT)

\$_____ was received in 1982 for use of my boat for purposes other than charter and commercial fishing.

_____ I did not use by boat for commercial activities other than charter fishing.

14. What share of your charter fishing business in 1982 came from repeat customers. (CHOOSE ONE)

_____ All of my charter fishing business in 1982 came from repeat customers.

_____ 75% to 99%

_____ 50% to 74%

_____ 25% to 49%

_____ 0% to 24%

15. What services did you provide to your charter fishing customers in 1982? (CHECK ALL ANSWERS THAT ARE TRUE FOR YOU)

_____ Hotel pick-up/drop-off

_____ Free beverages on board

_____ Free lunch or snacks on board

_____ Fish cleaning

_____ Fish cold storage

_____ Transfer of fish to taxidermist

_____ Free parking

IN THIS SECTION, WE ARE INTERESTED IN SPECIFIC INFORMATION RELATED TO YOUR FISH CATCHES AROUND FISH AGGREGATING BUOYS.

1. Please indicate the share of your total catch in 1982 that was caught within $\frac{1}{2}$ mile of a Fish Aggregating Buoy (FAD). (CHOOSE ONE)

_____ All of my 1982 catch was caught within $\frac{1}{2}$ mile of Fish Aggregating Buoys.

_____ 75% to 99%

_____ 25% to 49%

_____ 50% to 74%

_____ 0 to 24%

2. What share of your charter trips involved fishing within $\frac{1}{2}$ mile of a Fish Aggregating Buoy (FAD) in 1982? (CHOOSE ONE)

_____ All of my charter trips involved fishing near Fish Aggregating Buoys.

_____ 75% to 99%

_____ 25% to 49%

_____ 50% to 74%

_____ 0% to 24%

3. Which of your costs have been reduced as a result of fishing near Fish Aggregating Buoys. (CHECK ALL ANSWERS THAT ARE TRUE FOR YOU)

_____ Fuel and Oil Costs Reduced by _____%

_____ Labor Costs Reduced by _____%

_____ Repair Costs Reduced by _____%

_____ Gear Costs Reduced by _____%

_____ Ice Costs Reduced by _____%

_____ Bait Costs Reduced by _____%

_____ TOTAL COSTS REDUCED BY _____%

4. Do you think your annual number of customers increased over the last three years as a result of fishing near Fish Aggregating Buoys?

_____ YES Increased by _____%

_____ NO

IN THIS FINAL SECTION WE WOULD LIKE TO ASK YOU SOME QUESTIONS ABOUT YOUR BACKGROUND WHICH WILL HELP US COMPARE YOUR ANSWERS TO THOSE OF OTHER CHARTER FISHING VESSEL OWNERS. WE STRESS THAT ALL OF YOUR ANSWERS ARE STRICTLY CONFIDENTIAL.

1. How old are you? _____ years old
2. How many years have you been in the charter fishing business?
_____ years
3. Are you _____ male ? _____ female ?
4. How many years of school have you completed?
_____1 _____2 _____3 _____4 _____5 _____6 _____7 _____8 _____9
_____10 _____11 _____12 _____some college _____B.A. or equivalent
_____M.A. or equivalent _____ Advanced degree (M.D., Ph.D., etc.)

WE HOPE THAT YOU FOUND THIS QUESTIONNAIRE TO BE AN INTERESTING AND ENJOYABLE EXPERIENCE.

PLEASE RETURN YOUR COMPLETED
QUESTIONNAIRE AT YOUR EARLIEST
CONVENIENCE IN THE ENCLOSED
SELF-ADDRESSED STAMPED ENVELOPE.

THANK YOU AGAIN
FOR YOUR
HELP
AND
COOPERATION.

CONFIDENTIAL!

CONFIDENTIAL!

CONFIDENTIAL!

CONFIDENTIAL!

APPENDIX B

FOLLOW-UP TELEPHONE SURVEY INSTRUMENT

SURVEY I.D. NO. _____

VESSEL I.D. NO. _____

REG. OWNERS NAME _____

ISLAND LOCATION _____

May I speak with (owner's name)?

This is JOHN SPROUL from the University of Hawaii, Dept. of Agriculture and Resource Economics. I'm doing a personal follow-up on our Charter Fishing Survey we recently mailed out to you. Do you recall receiving it?

I would like to ask you a few very short questions concerning your charter fishing business so as to save you the inconvenience of filling out the questionnaire.

Do you offer charter fishing services?

YES NO

Did you use your boat for commercial fishing in 1982?

YES NO

If yes, how many days? _____

Do you consider yourself a full-time or part-time charter boat operator?

Full-time Part-time

What is your home port from which you base your charter business?

How long have you been a charter fisherman? _____

What is your present age? _____

How many charter trips did you take in 1982? _____

What percent of those trips taken in 1982 included fishing within 1/2 mile of an FAD? _____

What was the approximate number of fish caught by your charter business in 1982? _____

What types of fish did you mostly catch? _____

In your opinion, what was the market value of your charter fishing boat in 1982? _____

When did you purchase your charter boat? _____

What was the price you paid for your charter boat? _____

How many more years could your boat be used for charter fishing?

What was your total gross revenues which you earned from your charter boat business? _____

Finally, what was the main reason for not responding to the mail questionnaire we sent you?

Thank you for your participation and willingness to help us out with this charter fishing survey. If you have any questions concerning the validity of this survey or perhaps comments that you would like to make, you can contact the project's principal investigator Dr. Karl Samples at the University of Hawaii at 948-8360.

Thanks again for your help.

APPENDIX C

A BRIEF TECHNICAL DESCRIPTION OF INPUT-OUTPUT
(I-O) MODELING

Interested readers will find a complete discussion of input-output analysis in a standard reference written by Miernyk. The essence of input-output (I-O) modeling is that sectors in an economy are related in an explicit sense. Firms purchase goods and services from other firms, and in turn use these goods as inputs in the production of intermediate and final products. Final or finished products are sold to households, or exported from the region. This interaction between firms is expressed mathematically as:

$$x_{11} + x_{12} + \dots + x_{1n} + y_1 = X_1$$

$$x_{21} + x_{22} + \dots + x_{2n} + y_2 = X_2$$

$$x_{n1} + x_{n2} + \dots + x_{nn} + y_n = X_n$$

where: x_{ij} = sales from sector i to sector j

($i=1, \dots, n; j=1, \dots, n$)

y_i = final demand for products of sector i

($i=1, \dots, n$)

X_i = total output of sector i

($i=1, \dots, N$).

In modeling I-O relationships, it is assumed that sectors utilize linear production technologies. That is, production functions are assumed to be homogeneous of degree one, hence there are no economies or diseconomies of scale. Thus it is possible to define the production activity for each sector in terms of input-output (or technical) coefficients:

$$a_{ij} = \frac{x_{ij}}{X_j}$$

where X_j = total input requirements for sector j .

Using technical coefficients the equation system given above may be rewritten so as to express the interdependencies of the various sectors:

$$a_{11}X_1 + a_{12}X_2 + \dots + a_{1n}X_n + y_1 = X_1$$

$$a_{21}X_1 + a_{22}X_2 + \dots + a_{2n}X_n + y_2 = X_2$$

$$a_{n1}X_1 + a_{n2}X_2 + \dots + a_{nn}X_n + y_n = X_n$$

In matrix notation this is expressed as:

$$AX + y = X$$

where: $X = n \times 1$ vector of sector outputs
 $y = n \times 1$ vector of final demand
 $A = n \times n$ matrix of input-output coefficients
 (also called the technical coefficient table).

Since it is of interest to determine the level of output as a function of final demand, the equation system is rearranged as:

$$AX + y = X$$

$$y = X - AX$$

$$y = X(I-A)$$

$$X = (I-A)^{-1}y$$

where: $I =$ identity matrix

$(I-A)^{-1} =$ interdependency table

This equation system is the heart of input-output analysis. It expresses the vector of sector outputs as a linear function of final demands. Consequently, if changes in final demand are assumed to occur, subsequent changes in sector outputs can be determined.

Input-output analysis relies on the multiplier concept. The sales of output multiplier is defined as:

$$s = [(I-A)^{-1}]' * j$$

where: $s = n \times 1$ vector of output multipliers
 $j = n \times 1$ sum vector

Sales multipliers (one for each industry) are therefore the column sums of the matrix $(I-A)^{-1}$. The interpretation of the output multiplier is that if final demand for output of sector j were to change by one unit, the output in the entire economy would change by the magnitude of section j 's output multiplier.

The following is an illustration of a simplified model. The starting point in any I-O modelling process is construction of the transaction table. The transaction table (see Table C.1) summarizes economic activity that occurs within a given region. The columns of the table represents sales from the various row industries; the rows represent sales to the various column industries. For example, by reading down the first column of Table C.1, it becomes evident that industry A purchases \$2 worth of goods and services from itself, \$3 from industry B, \$1 from industry C, it paid \$3 in wages to households, and spent \$1 on imports (which is a leakage since it is an outflow of money from

Appendix Table C.1 Hypothetical Transaction Table

Purchasing Sectors Producing Sectors				Final Demand		Total Output
	Industry A	Industry B	Industry C	Households	Other	
Industry A	2	4	1	1	2	10
Industry B	3	10	2	10	15	40
Industry C	1	2	4	23	20	50
Households	3	19	30	0	1	53
Imports	1	5	13	0	0	19
Total Input	10	40	50	34	38	172

a region). Reading across the top row reveals that industry A sold \$2 worth of goods and services to itself, \$4 to B, \$1 to C, \$1 to households, and \$2 to other final demand. Note that total industry sales (total inputs) must equal total industry sales (total outputs). The transaction table identifies where industries buy and sell and presents a static picture of interindustry sales within a regional economy.

The technical coefficient table (see Table C.2) is developed next. Each element in this table is the ratio of an industry's purchases from specific industries divided by its total purchases. The table shows the direct dollar purchases required from each row industry for each dollar sales in each column industry. For example, for every \$1 worth of sales that industry A makes, it had to purchase \$.2 worth of goods from itself, \$.3 worth from industry B, and \$.1 from industry C. Since industry B requires purchases of various inputs to support its sale to A there arises, as mentioned earlier, repeated rounds of respending occur and thus a multiplier phenomenon is observed.

Table C.3 is the interdependence table. It is derived by performing the required matrix algebra on the technical coefficient table. The table shows the direct and indirect effect of a dollar's sales by each column industry after repeated rounds of spending have occurred. The interdependence table shows that each \$1 sales by industry A, B, and C respectively increases total regional economic production by \$2.03, \$1.68, and \$1.20. These numbers are referred to as the Type I output or sales multipliers. Type II multipliers are devised by including households and the effects of their respending in the interdependence table.

Appendix Table C.2 Hypothetical Technical Coefficient Table (A)

	Industry A	Industry B	Industry C
Industry A	.2	.1	.02
Industry B	.3	.25	.04
Industry C	.1	.05	.08

Appendix Table C.3 Hypothetical Interdependence Table

	Industry A	Industry B	Industry C
Industry A	1.32155	.17834	.0364963
Industry B	.537841	1.40991	.0729927
Industry C	.172877	.0960431	1.09489
Type I Multiplier	2.03227	1.6846	1.20438

APPENDIX D

ESTIMATED INPUT-OUTPUT TABLES FOR CHARTER BOAT FISHING

Appendix Table D.1 Interindustry Transaction Table

PURCHASING INDUSTRY
(SEE LEFT FOR TITLE)

INDUSTRY	1	2	3	4	5	6	7	8	9	10
1 CHARTER FISHING	0	0	0	0	0	0	762.71	0	0	0
2 SUGARCANE	0	0	0	0	365.00	0	0	0	0	0
3 PINEAPPLE	0	0	0	0	0	42256	721.73	0	0	0
4 OTHER AGRICULTURE	57.82	75.562	146.05	6445.1	0	597.55	80829	212.07	1744.7	22.132
5 SUGAR PROCESSING	0	0	0	44.162	0	2726.1	9314	0	0	0
6 PINEAPPLE CANNING	0	0	0	1714.8	0	62.484	1751.6	9.7831	0	0
7 OTHER FOOD PROCESS.	116.62	0	0	18258	0	941.37	316.95	164.71	0	95.629
8 MISC. MANUFACTURING	575.65	28.985	5557	6651.9	7595.6	38371	31512	71416	201774	152542
9 CONSTRUCTION	0	76.9.2	69.767	139.43	1452.4	317.48	15153	15153	7187.8	3039.7
10 TRANSP. AND WAREHS.	341.8	4012.9	650.48	924.7	20984	7023.9	10455	60335	35199	111635
11 COMMUNICATION	64.022	1032.7	97.653	179.21	1018.9	487.72	2526.3	86.97.1	5489	906.4
12 ELECT. GAS SANIT.	27.846	1061	169.74	456	1424.6	1198	3521.9	1585	2571.5	5388.5
13 WHOLESALE TRADE	126.55	103.65	1645	393.2	5811.4	9821.9	2205	32193	66050	11958
14 RETAIL TRADE	98.306	0	182.26	407.34	151.33	38.42	202.95	66.9.88	51284	256.6
15 EATING AND DRINKING	0	118.33	13.683	0	533.12	221.48	974.14	688.8.5	7051.6	119.9
16 BANKING AND FINANCE	639.74	11431	1009.1	304.9.4	3724.7	1481.3	4595.5	23615	18833	36471
17 HOTELS	0	60.6.85	7.5735	43.223	542.27	25.358	91.57	285.4	209.74	477.62
18 HEALTH AND PROF. SERV.	222.17	16043	28.97.6	433.9.2	2023.2	295.69	2140.7	8216	8141	7140.4
19 OTHER SERVICES	615.47	2612.5	194.53	631.002	3389.1	1972.8	11027	22286	13891	25362
20 GOVT. ENTERPRISE	0	45.037	26.583	15.521	51.9.42	116.6	466.9	2879.7	623.24	197.5
21 OTHER INDUSTRIES	0	0	0	0	0	0	0	0	0	0
22 TOTAL LOCAL PURCHASES	286	84434	12667	46751	434251	107955	215704	2716.97	49321	372582
23 HOUSEHOLDS	3210.7	116000	46634	86124	77800	42000	75848	218.45	550365	451609
24 OTHER VALUE ADDED	57.95	145473	9443.2	23912	65142	19454	42985	25874	240179	35060
25 IMPORTS	1058.8	3919	7855.6	39189	16.907	227.91	135946	592341	518.11	223.69
26 CORRECTION ROW	-0.20256	-0.0094432	63.93	1314.6	-31704	-2.91045-11	1307.3	-2.3283E-10	1309154	224.74
27 TOTAL PRIMARY INPUTS	5237.5	300566	152540	159849	84245	256.08	4718.80	1409060	1602475	1026.53
28 TOTAL PURCHASES	8123.5	365100	76600	198231	594100	192200	4718.80	1602475	1398145	1398145

SELLING INDUSTRY

INDUSTRY	11	12	13	14	15	16	17	18	19	20	21
1 CHARTER FISHING	0	0	0	0	762.71	0	0	0	0	0	0
2 SUGARCANE	0	0	0	0	0	0	0	0	0	0	0
3 PINEAPPLE	0	0	0	11.917	1512.5	0	18.259	0	0	0	0
4 OTHER AGRICULTURE	0	14.892	35.631	0	1896	448.72	704.61	2187.4	433.37	0	0
5 SUGAR PROCESSING	0	0	0	0	1766.7	0	148.53	79.016	0	0	0
6 PINEAPPLE CANNING	0	0	0	2.3158	2902	0	4.107	0	0	0	0
7 OTHER FOOD PROCESS.	0	0	0	36.142	108747	183.79	1215.9	5873.4	90.526	0	0
8 MISC. MANUFACTURING	2889.4	38412	15802	19864	12841	33836	27218	21321	21850	1952.7	0
9 CONSTRUCTION	1014.2	1498.4	1655.4	4104.9	97328	20191	10891	6781.8	2303.6	0	0
10 TRANSP. AND WAREHS.	1107.2	5424.6	12577	2878.3	15309	7527.3	41950	890.9.1	5505.7	0	0
11 COMMUNICATION	5239.5	3338.8	15045	13389	6233.2	3484	7834.4	12878	550.56	0	0
12 ELECT. GAS SANIT.	26.81.8	46.998	6450.3	24826	22379	25205	48994	17489	2051.9	557.0	0
13 WHOLESALE TRADE	601.55	4617.3	13254	6132.2	80714	9197.7	8422.7	13335	2051.9	215.2	0
14 RETAIL TRADE	123.94	394.57	2498.8	1701.2	0	46.56.7	3302.1	1231	3624.8	56.434	0
15 EATING AND DRINKING	1380.8	1614.4	13236	4353.3	0	24399	4073	13674	7193.4	248.55	0
16 BANKING AND FINANCE	10054	11567	23449	6825	60617	470116	131777	62942	43405	2315.3	0
17 HOTELS	553.18	357.63	2387.4	732.22	550.35	3366.2	1309.2	3634.4	1505.1	23.546	0
18 HEALTH AND PROF. SERV.	2232.9	3507	11647	7571.9	11047	43331	8208.6	33997	10457	445.58	0
19 OTHER SERVICES	15235	2300.3	36365	35612	36250	60.568	506.37	29360	41688	1621.6	0
20 GOVT. ENTERPRISE	91.83	800.6	2317.2	4082.2	1971.6	10347	3917.7	5983.9	2608.3	50.718	0
21 OTHER INDUSTRIES	0	0	0	0	0	0	0	0	0	0	0
22 TOTAL LOCAL PURCHASES	44056	128459	157624	194347	387462	825793	359926	248.99	188784	17808	0
23 HOUSEHOLDS	183950	69000	345058	560561	308731	1284119	385777	740553	338058	69123	215035
24 OTHER VALUE ADDED	80007	191901	210418	263777	268633	1272572	209833	150764	119887	7738.8	0
25 IMPORTS	18558	113254	24705	22843	374837	82073	78060	60151	145840	4710.5	0
26 CORRECTION ROW	9020.5	147.8	6174.1	528	-128.9	0	11783	832.24	5750.4	864.5	4.3443
27 TOTAL PRIMARY INPUTS	291536	374302	58354	85380	511107	2839064	685434	97200	609536	8267	215040.9
28 TOTAL PURCHASES	335582	502762	743979	1047166	1338559	3464586	1045359	1220999	798320	104075	215040.9

SELLING INDUSTRY

SELLING INDUSTRY

INDUSTRY	TOTAL INDUSTRY DEMAND	PERSONAL CONSUMPTION	TOURIST PURCHASES	PRIVATE INVESTMENT	STATE & LOCAL GOVT.	FED. (def.)	FED. (civ.)	EXPORTS	TOTAL FINAL DEMAND	TOTAL SALES
1 CHARTER FISHING	1525.4	1929.8	466.83	0	0	0	0	0	6598.1	8123.5
2 SAILBOAT	38100	0	0	0	0	0	0	0	0	38100
3 PLEASURE	44520	1000	5821.6	0	200	0	0	2505.8	32080	76600
4 OTHER RECREATURE	112941	24115	2718.5	0	1995.3	0	7.34	5751.2	86350	159291
5 SUGAR PROCESSING	14079	6279.6	1426.5	0	212.61	0	0	572102	580021	594100
6 PLEASURE CANNING	6453.7	8000	746.22	0	290.17	0	0	176703	185746	192200
7 OTHER FOOD PROCESS.	165566	185895	64759	0	10260	7.2	103.61	71382	306224	471790
8 MISC. MANUFACTURING	736966	154442	36576	0	31365	282985	1153.3	3806.69	941401	1880757
9 CONSTRUCTION	140098	0	0	1138700	359490	117289	6898.2	0	1622277	1802475
10 TRANSP. AND WAREHSG.	364511	274789	708757	8662	31365	3310.4	702.27	14906	1034634	1399145
11 COMMUNICATION	140860	147162	5362.4	8662	23577	117289	6898.2	0	194732	335592
12 ELECT. GAS SUPPLY	245773	171542	0	14977	16814	8275.6	241.64	1675	256989	502762
13 RETAIL TRADE	321376	247198	75365	55736	37733	47473	466.26	0	422602	743979
14 WHOLESALE TRADE	73703	677463	275779	0	22385	1293.1	624.73	20000	973463	1047166
15 HOTELS AND DRINKING	90841	591366	659087	19966	857.25	0	-1.59	0	124727	133869
16 BANKING AND FINANCE	98968	2420012	33.09	0	3282.4	408.07	148.7	0	2475389	3464956
17 HOTELS	16743	116717	904985	0	436.93	235.72	1274.9	10140	102616	1045359
18 RETAIL TRADE	24155	810439	14560	0	119269	698.23	2568.2	0	958843	1220999
19 WHOLESALE TRADE	357404	190966	169286	0	26701	1891.5	870.56	9631.7	400915	796320
20 GOVT. ENTERPRISE	41031	37092	14924	37.59	9771.8	753.75	399.36	64.21	63044	2150439
21 OTHER INDUSTRIES	0	11032	0	0	88616	1161524	9426.8	0	2150439	2150439
22 TOTAL LOCAL PURCHASES	4595205	6077379	2946855	1265516	1586913	1627752	110384	1349794	1456592	15661797
23 HOUSEHOLDS	8105502	0	0	0	0	0	0	0	0	8105502
24 OTHER VALUE ADDED	3933169	0	0	0	0	0	0	0	0	3933169
25 INVENTORIES	2882774	0	0	0	179200	76882	5636	0	2925066	5007839
26 CORRECTION FOR	45148	0	0	0	179200	0	0	0	0	45148
27 TOTAL PRIMARY INVENTS	1456559	1759500	391066	508781	179200	76882	5636	0	2925066	17651659
28 TOTAL PURCHASES	19661798	7886879	3331921	1774297	1768113	1704634	120020	1349794	17891658	37455455

Appendix Table D.1, continued

PURCHASING INDUSTRY

SELLING INDUSTRY

***	INDUSTRY	1	2	3	4	5	6	7	8	9	10	21
1	CHAPERISHING	1.1	2.000E-6	1.815E-6	1.683E-4	2.457E-6	1.236E-5	.0017673	4.113E-6	5.035E-6	4.0057E-6	0
2	SUGARCANE	2.224E-4	1.021E-5	1.021E-5	.0015662	.64822	.0092816	.014053	1.37E-5	1.259E-5	1.259E-5	0
3	PINEAPPLE	6.461E-5	1.700E-6	.0021792	.0022363	6.80E-6	.2195	.0029349	1.229E-5	1.543E-5	1.06E-5	0
4	OTHER AGRICULTURE	.010525	4.264E-4	1.576E-5	.0024161	3.513E-4	.0046878	1.9344	3.724E-4	.0013795	2.615E-4	0
5	SUGAR PROCESSING	3.431E-4	1.461E-5	1.576E-5	.0024161	3.513E-4	.0046878	1.9344	3.724E-4	.0013795	2.615E-4	0
6	PINEAPPLE CANNING	1.604E-4	1.100E-5	2.513E-5	.0094428	1.200E-5	1.0004	.0057301	2.360E-5	2.605E-5	1.66E-5	0
7	OTHER FOOD PROCESS.	.016E6	4.119E-4	5.120E-4	.1036	4.403E-4	.0061879	1.0916	6.529E-4	8.847E-4	6.127E-4	0
8	MISC. MANUFACTURING	.087919	.080769	.079987	.049911	.071682	.23719	.094339	1.0531	1.2474	.12747	0
9	CONSTRUCTION	.0051838	.0047195	.0028156	.002605	.0062482	.0050097	.010702	1.0068	.005094	.005094	0
10	TRANSP. AND WAREHSG.	.052114	.016389	.013618	.011405	.050392	.053954	.034513	.042542	.028132	1.0929	0
11	ELECT. GAS SMITH.	.012475	.0053058	.0032191	.0032476	.0061363	.0068282	.0099649	.0070797	.0063353	.0091735	0
12	CONSTRUCTION	.001065	.033674	.0046349	.005336	.02334	.012024	.012792	.012265	.005546	.007117	0
13	WHOLESALE TRADE	.02259	.027226	.0027282	.028	.031235	.064697	.060742	.022451	.041977	.013229	0
14	RETAIL TRADE	.01311	.499E-4	.0027282	.0029441	8.6177E-4	.0014802	.0016566	.0010308	.029109	.0026733	0
15	EATING AND DRINKING	.0030323	.0023213	.0017331	.0015641	.0030635	.0041406	.0063379	.0053652	.002265	.002365	0
16	BAKING AND FINANCE	.10481	.021383	.02484	.02484	.037882	.024002	.025631	.0029673	.02265	.02265	0
17	HOTELS	6.495E-4	6.362E-4	4.876E-4	5.599E-4	.0014569	9.257E-4	8.029E-4	.001973	7.132E-4	7.681E-4	0
18	HEALTH AND PROF. SERV.	.032733	.045305	.037955	.02574	.033849	.013757	.01321	.0071723	.0496	.007963	0
19	OTHER SERVICES	.08794	.013135	.007279	.0070155	.016809	.021033	.034322	.018272	.016028	.025232	0
20	GOVT. ENTERPRISES	.0012	9.3751E-4	9.027E-4	6.5107E-4	.0017179	.0016719	.001627	.0021918	.0012574	.0021138	0
21	OTHER INDUSTRIES	1.46	1.2777	1.2067	1.3358	1.9357	1.7022	1.63	1.2077	1.3423	1.3387	0
22	TYPE I MULTILIER	0	0	0	0	0	0	0	0	0	0	1

SELLING INDUSTRY

***	INDUSTRY	1	2	3	4	5	6	7	8	9	10	21
1	CHAPERISHING	1.1	2.000E-6	1.815E-6	1.683E-4	2.457E-6	1.236E-5	.0017673	4.113E-6	5.035E-6	4.0057E-6	0
2	SUGARCANE	2.224E-4	1.021E-5	1.021E-5	.0015662	.64822	.0092816	.014053	1.37E-5	1.259E-5	1.259E-5	0
3	PINEAPPLE	6.461E-5	1.700E-6	.0021792	.0022363	6.80E-6	.2195	.0029349	1.229E-5	1.543E-5	1.06E-5	0
4	OTHER AGRICULTURE	.010525	4.264E-4	1.576E-5	.0024161	3.513E-4	.0046878	1.9344	3.724E-4	.0013795	2.615E-4	0
5	SUGAR PROCESSING	3.431E-4	1.461E-5	1.576E-5	.0024161	3.513E-4	.0046878	1.9344	3.724E-4	.0013795	2.615E-4	0
6	PINEAPPLE CANNING	1.604E-4	1.100E-5	2.513E-5	.0094428	1.200E-5	1.0004	.0057301	2.360E-5	2.605E-5	1.66E-5	0
7	OTHER FOOD PROCESS.	.016E6	4.119E-4	5.120E-4	.1036	4.403E-4	.0061879	1.0916	6.529E-4	8.847E-4	6.127E-4	0
8	MISC. MANUFACTURING	.087919	.080769	.079987	.049911	.071682	.23719	.094339	1.0531	1.2474	.12747	0
9	CONSTRUCTION	.0051838	.0047195	.0028156	.002605	.0062482	.0050097	.010702	1.0068	.005094	.005094	0
10	TRANSP. AND WAREHSG.	.052114	.016389	.013618	.011405	.050392	.053954	.034513	.042542	.028132	1.0929	0
11	ELECT. GAS SMITH.	.012475	.0053058	.0032191	.0032476	.0061363	.0068282	.0099649	.0070797	.0063353	.0091735	0
12	CONSTRUCTION	.001065	.033674	.0046349	.005336	.02334	.012024	.012792	.012265	.005546	.007117	0
13	WHOLESALE TRADE	.02259	.027226	.0027282	.0029441	8.6177E-4	.0014802	.0016566	.0010308	.029109	.0026733	0
14	RETAIL TRADE	.01311	.499E-4	.0027282	.0029441	8.6177E-4	.0014802	.0016566	.0010308	.029109	.0026733	0
15	EATING AND DRINKING	.0030323	.0023213	.0017331	.0015641	.0030635	.0041406	.0063379	.0053652	.002265	.002365	0
16	BAKING AND FINANCE	.10481	.021383	.02484	.02484	.037882	.024002	.025631	.0029673	.02265	.02265	0
17	HOTELS	6.495E-4	6.362E-4	4.876E-4	5.599E-4	.0014569	9.257E-4	8.029E-4	.001973	7.132E-4	7.681E-4	0
18	HEALTH AND PROF. SERV.	.032733	.045305	.037955	.02574	.033849	.013757	.01321	.0071723	.0496	.007963	0
19	OTHER SERVICES	.08794	.013135	.007279	.0070155	.016809	.021033	.034322	.018272	.016028	.025232	0
20	GOVT. ENTERPRISES	.0012	9.3751E-4	9.027E-4	6.5107E-4	.0017179	.0016719	.001627	.0021918	.0012574	.0021138	0
21	OTHER INDUSTRIES	1.46	1.2777	1.2067	1.3358	1.9357	1.7022	1.63	1.2077	1.3423	1.3387	0
22	TYPE I MULTILIER	0	0	0	0	0	0	0	0	0	0	1

PURCHASING INDUSTRY
(SEE LEFT FOR TITLE)

Appendix Table D.4 Interdependence Table: Direct, Indirect and Induced

PURCHASING INDUSTRY
(SEE LEFT FOR TITLE)

INDUSTRY	1	2	3	4	5	6	7	8	9	10
1 CHARTERFISHING	1.0003	2.142E-4	3.693E-4	4.633E-4	2.304E-4	2.7027E-4	.0019667	1.062E-4	2.333E-4	2.3067E-4
2 SUGARCANE	.0011301	1.0006	.0011162	.0024533	.6469	.010057	.014653	3.310E-4	7.058E-4	6.947E-4
3 PINEAPPLE	5.723E-4	3.628E-4	1.0006	.0027326	3.903E-4	.22039	.0032705	1.893E-4	3.596E-4	3.502E-4
4 OTHER AGRICULTURE	.01952	.0069873	.013546	1.061	.0073972	.01286	.1956	.0036338	.008424	.007879
5 SUGAR PROCESSING	.0017434	9.994E-4	.001722	.0037847	1.0011	.015516	.022606	.0010901	.0010718	.0010718
6 PINEAPPLE CANNING	.0013907	8.763E-4	.0015243	.010645	9.413E-4	1.0015	.0065433	9.615E-4	9.4097E-4	9.4097E-4
7 OTHER FOOD PROCESS.	.0464	.021214	.0036539	.1325	.022773	.031456	1.1111	.023271	.023271	.023271
8 MISC. MANUFACTURING	1.2757	1.0666	.08668	.12831	.10164	.27108	1.2055	.15476	.15476	.15476
9 CONSTRUCTION	.017731	.013545	.015726	.016193	.015726	.016193	.013304	1.01089	1.01089	1.01089
10 TRANSP. AND WAREHSG.	.093495	.045497	.064046	.051855	.089523	.061468	.057011	.059467	.059467	.059467
11 COMMUNICATION	.037416	.022849	.033612	.027626	.024976	.028145	.025851	.0158	.02522	.027908
12 ELECT. GAS SANIT.	.03946	.055727	.042842	.035982	.049024	.038621	.033517	.033228	.023259	.030680
13 WHOLESALE TRADE	.06219	.058703	.075508	.067327	.061165	.098561	.08592	.036304	.071578	.045981
14 RETAIL TRADE	.088653	.054338	.096002	.077759	.056681	.0669	.052252	.027794	.067067	.060168
15 EATING AND DRINKING	.074058	.05228	.086284	.070966	.056715	.064645	.051582	.030199	.060106	.056533
16 BANKING AND FINANCE	.44079	.27856	.4308	.35325	.29167	.31115	.24771	.13964	.27801	.29118
17 HOTELS	.014656	.010483	.017555	.01425	.012037	.0129	.010061	.006864	.011316	.011269
18 HEALTH AND PROF. SERV.	.13407	.11658	.16144	.12479	.11039	.10036	.080193	.04303	.12609	.084022
19 OTHER SERVICES	.13065	.043176	.059323	.04876	.04907	.057536	.062553	.033205	.04867	.057312
20 GOVT. ENTERPRISE	.0078936	.005457	.0071935	.0077741	.0073928	.0073928	.0062872	.0045322	.0063257	.0071417
21 OTHER INDUSTRIES	.0012205	8.5847E-4	.0014873	.0011929	9.2193E-4	.0010431	8.0675E-4	9.241E-4	9.241E-4	9.1676E-4
22 HOUSEHOLDS	.89572	.63074	1.0927	.87647	.67737	.76641	.59274	.31354	.67899	.67357
23 SUM OF ROWS	3.239	2.5289	3.0745	3.0745	3.2795	3.2795	2.806	1.8297	2.6893	2.675
24 TYPE II MULTIPLIER	2.3423	1.8982	2.2818	2.1981	2.6022	2.4563	2.2132	1.5161	2.0103	2.0014

INDUSTRY	11	12	13	14	15	16	17	18	19	20	21
1 CHARTERFISHING	3.367E-4	1.2197E-4	3.219E-4	3.406E-4	9.147E-4	2.698E-4	2.867E-4	3.983E-4	2.998E-4	4.013E-4	5.43E-4
2 SUGARCANE	.0010131	3.673E-4	9.697E-4	.0010252	.0026391	8.1303E-4	9.719E-4	.0012718	9.03E-4	.0012073	.0016332
3 PINEAPPLE	5.702E-4	2.088E-4	5.571E-4	5.890E-4	.0022135	4.6077E-4	5.101E-4	6.829E-4	5.13E-4	6.777E-4	9.135E-4
4 OTHER AGRICULTURE	.001518	.00391	.010294	.010656	.036895	.006802	.009972	.014876	.010057	.0125	.016784
5 SUGAR PROCESSING	.0015629	5.6677E-4	.001495	.0015816	.0040714	.0012543	.0014955	.0019521	.0013945	.0018625	.0025196
6 PINEAPPLE CANNING	.0013725	4.97E-4	.0013193	.0013908	.0035604	.0011011	.0011653	.0016349	.0012266	.0016363	.0022138
7 OTHER FOOD PROCESS.	.033137	.012104	.032156	.033569	1.0977	.03762	.029616	.042504	.029835	.035427	.0532
8 MISC. MANUFACTURING	.057315	.10832	.070481	.07065	.052621	.053455	.081541	.076511	.075299	.085	.071352
9 CONSTRUCTION	.018885	.010617	.017974	.021979	.014406	.044513	.037073	.026031	.024115	.040535	.022578
10 TRANSP. AND WAREHSG.	.051291	.034139	.064132	.052061	.046309	.041476	.087191	.065381	.056189	.11456	.074466
11 COMMUNICATION	1.045	.019079	.04971	.04305	.024926	.034758	.035006	.04448	.0431	.039898	.04488
12 ELECT. GAS SANIT.	.045026	1.1177	.04433	.063174	.042216	.038038	.084421	.05661	.042981	.065363	.056419
13 WHOLESALE TRADE	.048094	.029702	1.0629	.053121	.095141	.004987	.050685	.05626	.0408739	.061049	.071297
14 RETAIL TRADE	.065255	.031352	.081974	1.0876	.05056	.059485	.076039	.098631	.10307	.13774	.13774
15 EATING AND DRINKING	.08601	.032754	.091987	.084887	1.0491	.071004	.072926	.10315	.079811	.057424	.06457
16 BANKING AND FINANCE	.41123	.1669	3.6859	4.5617	2.8164	1.4554	.46991	4.9428	3.9705	.057424	.60457
17 HOTELS	.017341	.0666192	.01788	.016627	.010073	.013539	1.0148	.021135	.01568	.01893	.025203
18 HEALTH AND PROF. SERV.	1.2055	.049876	1.2314	.01216	.10583	1.0583	1.0304	1.1645	.14101	1.6234	.16234
19 OTHER SERVICES	.097928	.039747	1.0076	.08786	.06569	.061567	.098774	.065013	1.1028	.07686	.07686
20 GOVT. ENTERPRISE	.010654	.0081872	.010445	.012065	.006729	.0036624	.011239	.014157	.010573	.0102	.012045
21 OTHER INDUSTRIES	.0013463	4.7873E-4	.001243	.0013606	7.977E-4	.0010645	.001139	.001594	.001785	.0016124	1.0022
22 HOUSEHOLDS	.96933	.35173	.91327	.9957	.56616	.78209	.83685	1.1384	.6588	1.1847	1.6136
23 SUM OF ROWS	3.1313	2.025	3.085	3.2226	2.5663	2.8522	3.1097	3.523	3.022	3.5739	4.2012
24 TYPE II MULTIPLIER	2.1421	1.6732	2.1717	2.2229	1.9802	2.0801	2.2729	2.3845	2.1562	2.3899	2.5876

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